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NUCLEAR SCIENCE ABSTRACTS

Volume 17 Number 10

Abstracts 15532–17621

May 31, 1963

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Volume 17, Number 10, May 31, 1963

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TABLE OF CONTENTS

Volume 17, Number 10, May 31, 1963

Category	Page
GENERAL AND MISCELLANEOUS	2013
BIOLOGY AND MEDICINE	2015
General and Miscellaneous	2015
Biochemistry, Nutrition, and Toxicology	2022
Fallout and Ecology	2026
Radiation Effects on Living Tissues	2027
Radiation Sickness	2058
CHEMISTRY	2065
General and Miscellaneous	2065
Analytical Procedures	2069
Inorganic and Physical Chemistry	2077
Organic Chemistry	2089
Radiation Chemistry and Radiochemistry	2090
Raw Materials and Feed Materials	2101
Separation Processes	2102
ENGINEERING AND EQUIPMENT	2107
General and Miscellaneous	2107
Heat Transfer and Fluid Flow	2112
Materials Testing	2118
GEOLOGY, MINERALOGY, AND METEOROLOGY	2119
HEALTH AND SAFETY	2126
INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS	2133
INSTRUMENTS AND INSTRUMENTATION	2136
General and Miscellaneous	2136
Radiation Detection	2140
ISOTOPE SEPARATION	2149
MATHEMATICS AND COMPUTERS	2151
METALS, CERAMICS, AND OTHER MATERIALS	2153
General and Miscellaneous	2153
Corrosion	2160
Fabrication	2163
Properties and Structure	2167
Radiation Effects	2180
PHYSICS	2186
General and Miscellaneous	2186
Astrophysics and Cosmology	2205
Cosmic Radiation	2206
Criticality Studies	2209
Elementary Particles and Radiations	2209
Neutron Physics	2226
Nuclear Properties and Reactions	2227
Particle Accelerators	2253
Plasma Physics and Thermonuclear Processes	2256
Shielding	2265
Theoretical Physics	2265
REACTOR TECHNOLOGY	2267
General and Miscellaneous	2267
Power Reactors	2280
Research Reactors	2288
SPACE APPLICATIONS AND TECHNOLOGY	2291
WASTE DISPOSAL AND PROCESSING	2293
CORPORATE AUTHOR INDEX	INDEX-1
PERSONAL AUTHOR INDEX	INDEX-10
SUBJECT INDEX	INDEX-49
REPORT NUMBER INDEX	INDEX-120

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Volume 17, Number 10 May 31, 1963

NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

15532 (BMI-1607(Del.)) PROGRESS RELATING TO CIVILIAN APPLICATIONS DURING DECEMBER 1962. Russell W. Dayton and Ronald F. Dickerson (Battelle Memorial Inst., Columbus, Ohio). Jan. 1, 1963. Contract W-7405-eng-92. 79p.

Progress is reported in programs concerning reactor materials and components, studies of fuels, studies of PuN systems, general fuel-element development, radiation uses, tracer evaluation of filters, materials for NPR, coated-particle fuels, corrosion in fluoride volatility processes, creep-rupture behavior of SAP alloys, fission product deposition studies, radiation effects on fuels and reactor materials, the ML-1 program, and joining of regenerative cell components. (J.R.D.)

15533 (NP-12645) BRIEF ANNUAL REPORT, 1962–63. (India. Atomic Energy Establishment, Trombay). 22p.

Developments in atomic energy in India for 1962 are reported. Topics covered include: Atomic Energy Establishment, Trombay, atomic power, atomic minerals, Jaduguda mines, industrial operations, international relations, space research, architecture and civil engineering, Tata Institute of Fundamental Research, other institutions, and other activity. (M.C.G.)

15534 (TID-3522(Rev.6)) PEACEFUL USES FOR NUCLEAR EXPLOSIVES. A Selected Annotated Bibliography. Hugh E. Voress, Richard J. Smith, comps. (Division of Technical Information Extension, AEC), and Carl R. Gerber, comp. (Division of Peaceful Nuclear Explosives, AEC). Jan. 1963. 43p.

A bibliography, on the peaceful uses for nuclear explosives, presents 215 annotated references arranged by subject including reports and published literature through December 1, 1962. Field experiments are currently underway to evaluate proposals in two general areas: scientific applications and excavation applications. The most promising application is excavation. The PLOWSHARE project initiated for studying the use of nuclear explosives for peaceful purposes has developed many potential applications in such areas as mining, harbor and canal excavation, water management, oil recovery, and production of isotopes. (H.G.G.)

15535 (UCRL-Trans-904) A EUROPEAN RESEARCH CENTER FOR RADIATION BIOLOGY CLINICAL RADIOLOGY AND RELATED FIELDS OF KNOWLEDGE (MEMORANDUM). Rolf Wideroee and Hedi Fritz-Niggli. Translated by Senta Pugh (Univ. of California Lawrence Radiation Lab., Berkeley). 1962. 25p.

The foundation of an European research center for radiation biology, clinical radiology, and related fields of knowledge has been proposed. The objectives of the foundation are defined and a model is presented for use in the development of such an institute. (C.H.)

15536 EFFECT OF THE U. S. HIGH-ALTITUDE NUCLEAR EXPLOSION ON RADIO WAVE PROPAGATION. P. Rohan, L. L. Anderson, and D. J. Cooke (Weapons Research Establishment, Salisbury, South Australia). Nature, 197: 887-8(Mar. 2, 1963).

The effects of ionization, caused by the nuclear test explosion about 200 mi over Johnston Island on July 9, 1962, on radiowave propagation were measured in Australia. Signals of the very low-frequency transmitter located near Seattle, Wash., and signals from a transmitter located in the Panama Canal Zone were monitored. The signal strength dropped suddenly but recovered after about 15 min, to drop again at about 1900 hr, followed by a steady rise. (C.H.)

15537 MAGNETO-TELLURIC EFFECTS OBSERVED IN DALLAS, TEXAS, FROM THE JULY 9, 1962, HIGH-ALTITUDE NUCLEAR EVENT. Jack J. Burch and Arthur W. Green, Jr. (Texas Instruments Inc., Dallas). Nature, 197: 960-3(Mar. 9, 1963).

The U. S. Atomic Energy Commission detonated a megaton-range nuclear device over Johnston Island at an altitude of 250 miles on July 9, 1962, at about 09 hr 00 min 09 sec, U.T. Data are presented on magnetic field and electric field variations at Dallas, Texas, produced by this event. (C.H.)

15538 PERIOD AND AMPLITUDE IN ATMOSPHERIC GRAVITY WAVES FROM NUCLEAR EXPLOSIONS. H. Waegner and U. Ericsson (Research Inst. of National Defence, Stockholm). Nature, 197: 994(Mar. 9, 1963).

A log-log plot is presented of the peak-to-peak pressure Δp of the first full cycle of the waves against the period τ measured from the first to the second overpressure peak taken from microbarographic records, made in Stockholm, of nuclear explosions in the vicinity of Novaya Zemlya. The instrument response is essentially flat for lengths of periods between 0.5 and 300 sec. All points correspond to explosions seismically recorded in Uppsala during 1961 and 1962. The sites of the explosions from Stockholm are in the range of 1,900 to 2,300 km. Results indicate a proportionality between W and τ^2. (C.H.)

15539 SHOCK-LAYER RADIATION OF BLUNT BODIES TRAVELING AT LUNAR RETURN ENTRY VELOCITIES. William A. Page (National Aeronautics and Space Administration, Moffett Field, Calif.). Preprint Paper No. 63-41.

New York, Institute of the Aerospace Sciences, 1963. 38p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Measurements were made of total thermal radiation from the shock layer about small gun-launched models flying either in still air or upstream through the test section of a shock-tube-driven hypersonic wind tunnel. Total velocities ranged up to 41,000 ft/sec. Current knowledge of shock-layer radiation is evaluated by comparing the results with available predictions of equilibrium radiation and with shock-tube measurements of nonequilibrium radiation. Scaling rules and methods for predicting radiative heating of full-scale vehicles are discussed. (auth)

15540 GEOLOGIC EFFECTS OF THE HIGH-EXPLOSIVE TESTS IN THE USGS TUNNEL AREA, NEVADA TEST SITE. J. M. Cattermole and W. R. Hansen (Geological Survey, Washington, D. C.). Geological Survey Professional Paper 382-B. 1962. 30p., 6 illus. (GPO)

During the winter and spring of 1956-57 the U. S. Geological Survey ran a series of underground high-explosive tests at the Nevada Test Site. The purpose of these experiments, and of the subsequent relatively low yield Rainier nuclear blast, was to determine the feasibility of underground detonation as a method of testing atomic devices. In developing parameters for the effectiveness of various-sized explosions in rock, the following formula relating to depth of containment was used: $D = k\sqrt[3]{W}$, where D = depth of cover, in feet, k = constant, W = weight of explosive in pounds. Although this formula has limitations, its use provides a good empirical basis for estimating the probable behavior of a given underground explosion. The USGS Tunnel consists of a main access-way 308 feet long and two lateral tunnels oriented at right angles to the main tunnel and terminated in explosion chambers, rooms A and B (10-ton and 50-ton explosion chambers, respectively). The workings were dug in tuffaceous pyroclastic rock of the Oak Spring formation of Tertiary age. This rock, which is rhyolitic to quartz latitic, consists chiefly of altered ash shards and pumice fragments but contains various phenocrysts of quartz, feldspar, and mafic minerals, and lithic inclusions. The rock is tunneled easily and generally stands well underground without support. Several small explosive charges of various sizes were fired in drill holes at various depths in the Oak Spring formation. These charges gave values for k in the formula that ranged from 2.45 to 3.33. The 10-ton explosion was fired in room A on February 21, 1957, under 92 feet of minimum cover. A roughly oval area covering about 3,700 square feet was permanently raised 1 foot or more above its former position, and a subcircular area of nearly 12,000 square feet was lifted half a foot or more. Numerous fractures that were opened at the ground surface coincided chiefly with preexisting natural fractures. An instant after the shot was detonated, a horizontally directed blast of gas, dust, and rock emerged at high velocity from the portal of the tunnel. Underground, part of the wall of the explosion chamber had failed, permitting the gas generated by the explosion to bypass the stemming. The explosion chamber itself was greatly enlarged by the blast. The 50-ton explosion was fired in room B on April 5, 1957, under a minimum of 165 feet of cover. This explosion temporarily updomed the ground surface above the chamber about 26 feet and permanently lifted it locally as much as 6 feet. The area strongly disturbed by the blast covers about 12,000 square yards and is roughly triangular in shape. Most of the strongest surface displacements were along preexisting fractures, but many surface fractures were formed within previously sound rock. Within 200 feet of ground zero the fracture pattern in previously sound rock was radial. Underground, the rock was severely fractured around the explosion chamber and the tunnel was closed by debris. Subsequently, entry to the chamber was reestablished, but most of the debris was not removed. As classed by their surface and underground effects, the 10-ton and 50-ton explosions were not fully contained. The k factor for containment of the 10-ton shot is calculated as 3.7, and 9.3 tons of 60-percent gelatin dynamite would be the amount for exact containment. The k factor for containment of the 50-ton shot is calculated as 4.1, and 38.2 tons of dynamite would be the amount for exact containment. (auth)

BIOLOGY AND MEDICINE

General and Miscellaneous

Refer also to abstract 15911.

15541 (ORO-598) SEMI-ANNUAL PROGRESS REPORT [ON AGRICULTURAL RESEARCH], JANUARY 1–JUNE 30, 1962. (Tennessee. Univ., Oak Ridge. UT-AEC Agricultural Research Lab.). Contract AT-40-1-GEN-242. 121p.

Progress is reported in studies on the clinical aspects of radiation injuries in laboratory and domestic animals. Data are included on the status of burros surviving whole-body exposure to neutrons and γ radiation in the lethal dose range; the status of swine surviving neutron and γ exposure from an atomic detonation; a comparison of the toxic effects of Sr^{90} and Ra in sheep; the development of techniques for the visual observation of the cerebral hemisphere in irradiated sheep; studies on radiation tumorogenesis in rats and sheep; and the effects of actinomycin D on growth rate, blood picture, and $LD_{50/30}$ radiation response in rats. Three Hereford cows are reported surviving from a group of 60 animals exposed to radioactive fallout from the first atomic bomb test at Alamogordo, New Mexico, July 1945. Squamous cell carcinomas were removed from the area of β burns of one animal and autopsy findings are summarized for one animal that died in May 1962. Pathological findings included a squamous cell carcinoma in the area of β skin burn, malignant lymphoma, pancreolithiasis, neoplasia of adrenal medulla, and uterine cyst. Studies were continued on the effects of radiation on the reproductive cycle in large animals. Data are included on the effect of chronic irradiation on sperm production in bulls; and the effects of prenatal irradiation on anatomical development in calves, swine, and rabbits. Necropsies were performed on 57 cadavers from 4 species exposed to various radiation doses. Pertinent data are summarized on cows, burros, sheep, and swine. The metabolism of fission products and chemically related nuclides was investigated in beef cattle, sheep, swine, and poultry. Data are included on the effects of whole-body irradiation on the metabolism of Sr^{89}, Ca^{45}, and Se^{75} in swine. Emphasis was placed on the pathway of fission product entry into milk and possible means of metabolic control. Studies were continued on soil properties that affect the availability of fission product elements to plant roots. Investigations were also continued on applications of radiation in plant breeding studies. Data are included on the influence of pregermination temperature and time on the radiosensitivity of dormant seeds of Nandina domestica, the effects of pre-irradiation humidity on the radiosensitivity of seeds, and the interaction of seed moisture with storage and oxygen effects on irradiated seeds. The radiosensitivity of carnation cuttings, tulip bulbs, and rooted cuttings of various ornamental plants such as Abelia, Pinus, Coleus, Forsythia, Rosa, and Ilex was investigated. Field scale mutation studies were made on plants from irradiated seeds of soybean and cotton. Seeds and other materials were irradiated for cooperators in the plant breeding program. A list is included of publications during the period covered by this report. (C.H.)

15542 (TID-18138) REACTIONS OF RIBONUCLEOTIDE DERIVATIVES OF PURINE ANALOGS AT THE CATALYTIC SITE OF INOSINE 5′PHOSPHATE DEHYDROGENASE. Alexander Hampton (Sloan-Kettering Inst. for Cancer Research, New York). [1962]. Contract AT (30-1)-910. 32p.

Mechanisms involved in the action of the antileukemic drugs 6-chloropurine, 6-mercaptopurine, and 6-thioguanine are discussed. 6-Chloro-9-β-D-ribofuranosylpurine 5′-phosphate irreversibly inactivates an inosine 5′-phosphate dehydrogenase. The process is slowed by non-inhibitory concentrations of inosine 5′-phosphate and accelerated by glutathione. The nucleoside was 200 times less effective for inactivation. Biochemical effects of 6-chloropurine in vivo can be ascribed to biosynthesis of its ribonucleoside 5′-phosphate and subsequent inhibition of xanthosine 5′-phosphate formation. 6-Thioinosine 5′-phosphate and inosine 5′-phosphate compete as substrates for the dehydrogenase when glutathione is present. When glutathione is absent, 6-thioinosine 5′-phosphate becomes markedly more inhibitory. This inhibition was reversible by glutathione but not by inosine 5′-phosphate. 6-Thioguanosine 5′-phosphate also inhibits much more strongly when glutathione is omitted, but the 5′-phosphates of guanosine and of 9-β-D-ribofuranosylpurine do not. 6-Thioinosine and its mixed 2′- and 3′-phosphates were not substrates and were much less potent inhibitors than 6-thioinosine 5′-phosphate. The 6-chloro- and the two 6-thio- nucleotides evidently bind to the reaction site in place of inosine 5′-phosphate and there react with a sulfhydryl group to form stable thioether and disulfide bonds, respectively. They also undergo similar non-enzymatic reactions with mercaptans under analogous conditions. A mechanism is postulated for xanthosine 5′-phosphate formation in which activation of inosine 5′-phosphate involves addition of a sulfhydryl group of the enzyme across the 1,6 double bond. (auth)

15543 (UCLA-511) LIVER BLOOD FLOW ESTIMATES (AVAILABLE TECHNIQUES AND CLINICAL SIGNIFICANCE). George V. Taplin (California. Univ., Los Angeles. School of Medicine). Feb. 1963. Contract AT-04-1-GEN-12. 41p.

Radioisotope techniques developed in the past 10 years give the physician new tools for the diagnosis and management of patients with hepatobiliary disease. The colloidal blood disappearance test of liver blood flow is certainly an improvement over the BSP technique which requires hepatic vein catheterization. The radio Rose Bengal test of polygonal cell function and bile flow interference is useful in the differential diagnosis of jaundice. The combined radiocolloid and Rose Bengal blood disappearance tests simplify evaluation of polygonal cell function, as related to impairment of hepatic circulation. The latter two procedures are especially useful in the management of cirrhotic candidates for portal caval shunt operations. Photoscans of the liver and spleen give valuable clues to many difficult diagnostic problems. The current radioisotope procedures are emerging from their early developmental stages. Their use in clinical practice is now expanding rapidly. Many problems remain only partially solved, but current interest and investigative efforts give promise of future advances. (auth)

15544 FUNDAMENTAL STUDIES ON CLINICAL USE OF THE SIX MILLION ELECTRON VOLT BETATRON. Susumu Morikawa (Kyoto Univ.). Acta Schol. Med., Univ. Kioto, 37: 25-58(Sept. 1960).

Depth dose measurements were made utilizing the high-

energy radiation generated by a 6 Mev betatron preliminary to its therapeutic use. The maximum depth dose was observed at a depth of 15 to 17 mm below the surface of various phantom materials simulating human tissues. In deeper regions, the percentage depth dose obtained by film techniques in a resinous wood phantom was slightly higher than that obtained by chamber methods in a water phantom. It was concluded that film techniques for depth dose measurements of high-energy radiation is of greatest practical value, but the calibration with an ionization chamber is also desirable. By filtration with 2-mm lead, removal of the contamination by soft radiation was not complete, and in order to obtain a lower surface dose and an increase of depth dose it was necessary to use a 10-mm lead filter. It was found that the dependency of depth dose on the field area was corrected simply by the application of a previously developed theoretical formula. Isodose distributions showed a very flat curve and a sharp contour of beam, which simplified the dose calculation for rotation therapy. The clinical usefulness of 6-Mev radiation is enhanced by its lower surface dose, high penetration, and less side scatter. (H.H.D.)

15545 PRACTICAL DOSIMETRY IN INTERSTITIAL THERAPY BY BETA SOURCE EMITTERS. André Wambersie (Université de Louvain, Belg.). Ann. Radiol., 5: R867-75(1962). (In French)

In this paper, which deals with beta dosimetry in interstitial therapy, a number of methods are presented for determining by calculation absorbed doses from radioactive grains. Where the surrounding tissue is homogeneous, simple formulas are available by which the doses absorbed from point sources, spheres, and other simple geometric forms can be calculated with sufficient accuracy. Where, on the other hand, the surrounding tissue is heterogeneous, as is the case for the majority of sources used in treatment, the problem is more complex and fewer experimental data are available. Three methods are presented for calculating the doses delivered by radioactive spheres more dense than the surrounding tissues. These methods, based on plausible hypotheses which simplify the issue, make use of the formulas established for homogeneous tissues. In the special case of the sphere of Y^{90}, comparison of the results obtained with each of the three methods shows a satisfying degree of agreement between them, the radiation corresponding to the different isodose curves differing by less than 10%. The cylindrical sources are broken down into inscribed spheres. The results are similar to those obtained by the longer method of breaking down into elementary volumes. The majority of the practical problems of beta dosimetry in interstitial therapy can be solved by the use of one or other of the methods of calculation just described. In the case of yttrium grains, which are in everyday use, the calculations which we have carried out lighten the work considerably. The results they give are accurate enough, when individual criteria and biological variations are taken into account. Comparison of the values calculated and the experimental results available shows, in the conditions studied, radiation differences of less than 10%. In view of the complexity of the problem, this agreement is very satisfactory. (auth)

15546 IRRADIATION AND MARROW INFUSION IN LEUKEMIA. OBSERVATIONS IN FIVE PATIENTS WITH ACUTE LEUKEMIA TREATED BY WHOLE-BODY EXPOSURES OF 1400 TO 2000 ROENTGENS AND INFUSIONS OF MARROW. E. D. Thomas, E. C. Herman, Jr., W. B. Greenough, III, E. B. Hager, J. H. Cannon, O. D. Sahler, and J. W. Ferrebee (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Arch. Internal Med., 107: 829-45 (June 1961).

Clinical and laboratory observations are described of 5 patients with acute leukemia following treatment by continuous Co^{60} whole-body exposures of 1400 to 2000 r at dose rates of 0.5 to 2 r/min. Marrow from normal volunteer donors was used. The studies indicated that fatal early gastrointestinal complications such as hemorrhagic diarrhea, perforation, and peritonitis are not likely to occur after exposures of 1200 to 2000 r, midline air dose, received at rates up to 2 r per min. Infection was the chief cause of death, but supportive measures sustained patients from 2 to 4 weeks. Recovery of marrow function within this period is essential, and when restoration of function is accomplished, recuperation is free from stigmata of radiation damage, except aspermia and loss of hair. Three patients in whom grafts of foreign marrow were attempted died of Escherichia coli infection. A second cause of difficulty may lie in the transfusions received by these patients before irradiation. Thus, immunization to foreign blood prior to radiation may make it impossible to engraft marrow. A third cause of difficulty may have been the use of fresh blood after irradiation. Serum amylase activity showed an immediate and marked rise after 2000 r whole-body irradiation. The observations suggest that irradiation at 900, 1200, and 1600 r, is not adequate to exterminate leukemia in man. (P.C.H.)

15547 THE IMPORTANCE OF ELECTRON SPIN RESONANCE MEASUREMENT IN BIOLOGY AND RADIATION BIOLOGY. Juergen Fraenz (Universität, Freiburg i. B.). Atomkernenergie, 8: 63-70(Feb. 1963). (In German)

The importance of the electron spin resonance (ESR) for studying biological problems under consideration of recent publications is discussed. A description of two main fields for the application of ESR in biology – ESR measurements of free radicals in biological mediums and in irradiated, biologically important, organic molecules – is given in detail. The reviewed publications show the following results: 1. For all biological processes, which intermediates are supposed to be free radicals, ESR measurements should be useful. 2. Free radicals in irradiated living material could be detected by ESR. 3. Most interesting work in the field of biological application of ESR is done on bacteria spores and seeds. 4. The hyperfine structures of the ESR pattern obtained from several amino acids could be explained by some authors. 5. The discussion about energy transfer in proteins has got quite a stimulation by ESR measurements on x-ray- and uv-irradiated proteins and amino acids. 6. Strong evidence is given by ESR measurements that radical intermediates are involved in photosynthesis and several enzymatic reactions. (auth)

15548 INFUSION OF MARROW IN THE MOUSE AND DOG AFTER THIO-TEPA. H. L. Lochte, Jr., S. Kasakura, M. Karetzky, Joseph W. Ferrebee, and E. Donnall Thomas (Mary Imogene Bassett Hospital, Cooperstown, N. Y.). Blood, 21: 424-8(Apr. 1963).

In mice and in dogs, the usefulness of infusions of marrow in reducing the toxicity of triethylenethiophosphoramide (thio-TEPA) is limited to a very narrow range of dose of drug in which prompt restoration of hematopoiesis seems critical to survival. Below this range, control animals recover spontaneously; above this range, damage to other organ systems precludes survival. (auth)

15549 DIFFERENTIATION BETWEEN VITAMIN B_{12}-DEFICIENT AND FOLIC ACID-DEFICIENT MEGALOBLASTIC ANEMIAS WITH C^{14}-HISTIDINE. Mathews B. Fish, Myron Pollycove, and Thomas V. Feichtmeir (Univ. of California, San Francisco and Univ. of California, Berkeley). Blood, 21: 447-61(Apr. 1963).

Intermediary metabolism of the monocarbon pool and histidine in normal subjects and patients with megaloblastic anemia was studied by continuous measurement of pulmonary excretion of $C^{14}O_2$ and urinary excretion of C^{14} after injection of L-histidine-2(ring)-C^{14}. Cumulative pulmonary and renal excretion of C^{14} for 1 month by two normal subjects approximates 45% of the amount injected. Within 4 months after injection of the dose used in this study, the resultant average tissue radiation decreases below the average natural terrestrial and cosmic radiation level. Simultaneous determination of cumulative 1-hour pulmonary C^{14} excretion and the time of occurrence of maximum $C^{14}O_2$-specific activity may permit rapid and unequivocal differentiation between folic acid deficiency and vitamin B_{12} deficiency in the pathogenesis of megaloblastic anemia. Folic acid deficiency results in marked diminution of pulmonary C^{14} excretion and marked prolongation of $C^{14}O_2$-specific activity, while both parameters are normal in patients with vitamin B_{12} deficiency and megaloblastic anemia. Measurement during periods of reticulocyte response to either folic acid or vitamin B_{12} demonstrated normal $C^{14}O_2$-specific activity but decreased pulmonary C^{14} excretion. These observations suggest that prolongation of $C^{14}O_2$-specific activity is a sensitive index of folic acid deficiency or block and that if T_{max} is normal, pulmonary C^{14} excretion is a sensitive index of the relative partition of the active monocarbon pool between pathways for oxidation and pathways for nucleic acid synthesis. This type of breath analysis seems to provide a quantitative dynamic representation of metabolic function which may be particularly useful in differentiating between the alterations of intermediary metabolism that occur in patients with folic acid-deficient megaloblastic anemia and in patients with vitamin B_{12}-deficient megaloblastic anemia. (auth)

15550 RADIOACTIVE IODINE IN THE DIAGNOSIS OF THYROID DISORDERS. Julio Bedoya Paredes (Junta de Control de Energia Atomica, Lima). Bol. Inform. Junta Control Energia Atomica (Peru), 7: 76-87(Sept.-Oct. 1962). (In Spanish)

The results of seven years study on the use of radioiodine in the diagnosis of thyroid disorders are tabulated and discussed briefly. I^{131} capture, proteic iodine, conversion index, and saliva index were measured for various thyroid disorders. The method used for the measurement of the saliva index is described, and it is concluded that this test gives the best results for hypofunction disorders. (J.S.R.)

15551 DISTRIBUTION OF P^{32}, Ca^{45}, AND Zn^{65} IN THE FRUITING BEAN (PHASEOLUS VULGARIS L.) AFTER ROOT ABSORPTION. REDISTRIBUTION OF THESE ELEMENTS DURING GERMINATION OF THE SEED AND THE DEVELOPMENT OF THE YOUNG PLANT. A. J. Riga (Institut Agronomique de l'État, Gembloux, Belg.), and M. J. Bukovac. Bull. Inst. Agron. Sta. Rech. Gembloux, 29: 165-96(1961). (In French)

The distribution of root-absorbed P^{32}, Ca^{45} and Zn^{65} in the fruiting bean (Phaseolus vulgaris L.) plant, the mature seed, and the redistribution of the elements during germination and seedling development was followed. The highest concentration of P^{32} and Zn^{65} was recovered in the actively growing plant parts and reproductive structures, whereas, Ca^{45} was found in higher concentrations in the older tissues. A major percentage of the seed-contained P^{32} and Zn^{65} (97 and 84%, respectively) was found in the cotyledons and 74% of the Ca^{45} was found in the seed coat. On a dry weight basis the greatest concentration of P^{32} and Zn^{65} was recovered in the epicotyl + hypocotyl + radicle. The greatest concentration of Ca^{45} was still found in the seed coat. All three nutrients (P^{32}, Ca^{45} and Zn^{65}) were translocated out of the cotyledons and into the remaining portions of the embryo at varying rates. After a six-day germination period 29, 14, and 54% of the cotyledon-contained P^{32}, Ca^{45}, and Zn^{65}, respectively, was translocated out of the cotyledons. Of the P^{32}, Ca^{45} and Zn^{65} transported out of the cotyledons, greater percentages were recovered in the hypocotyl + radicle (basipetal transport) than in the epicotyl (acropetal transport). The following order of mobility, Zn^{65}, P^{32}, and Ca^{45}, was established using as a criterion the percent of the nutrient present in the cotyledon at beginning of germination transported to other parts of the embryo. (auth)

15552 ON THE OCCURRENCE OF HYPOTHYROIDISM AFTER RADIOIODINE RESECTION. D. Farschidpur and P. Meiisel (Städt. Auguste-Viktoria-Krankenhauses, Berlin). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 98: 193-8(Feb. 1963). (In German)

An attempt was made to determine the dose of radioiodine in the treatment of hyperthyroidism with reference to the number of Cs and rep values. It was proved desirable to administer no more than 8 mC and 30,000 rep. An analysis of patients treated between 1956 and 1961 revealed six permanent cases of hypothyroidism; each had been treated with a greater dose than the above. The occurrence of hypofunction in cases treated with a dose greater than the above is compared statistically with cases treated with smaller doses. A number of examples are discussed. (auth)

15553 INVESTIGATION OF REDUCTION OF ABSORPTION OF RADIOACTIVE MATERIAL BY MEANS OF ASTRINGENTS. W. Lehrnbecher (CEN, Mol, Berg.). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 98: 199-207(Feb. 1963). (In German)

An attempt was made to use the astringent properties of two substances, adrenalin and tannin, for reducing skin absorption of radioactive substances on female Wistar rats. The effect of ½% adrenalin emulsion and of a 2% tannin solution on the absorption of a β-emitting substance ($Sr^{89}Cl_2$ solution) was observed over three periods of 30, 60, and 90 min. A reduction of absorption was found after using adrenalin and tanning. The effect of adrenalin was small, particularly over prolonged periods of observation, and there was a marked reduction of absorption resulting from the use of tannin during all periods of observation. A method is described that permits an estimate of the reduction in skin absorption of β rays. (P.C.H.)

15554 THE APPLICATION OF ISOTOPE EFFECTS IN THE STUDY OF BIOLOGICAL AND GEOLOGICAL PROCESSES. H. G. Thode (McMaster Univ., Hamilton, Ont.). Henry Ford Hosp. Med. Bull., 10: 501-21(Dec. 1962).

The physical basis for differences in equilibrium properties of isotopic substances is reviewed. It is pointed out that satisfactory agreement between theory and experiment is obtained when sufficient spectroscopic data are available to calculate the partition ratio for the isotopic molecules involved. Applications of equilibrium isotope effects, kinetic isotope effects, and deuterium exchange in studies of biological and geological processes are reviewed. Topics discussed include cation hydration and ion-solvent interaction, carbon isotope exchange between CO_2 and carbonate solutions, kinetic isotope effects in the study of rate theory, the use of a kinetic isotope effect and deuterium exchange to elucidate the mechanism of the carbonyl elimination reaction in benzylnitrate, and the distribution of the sulfur isotopes in nature. Data are included from studies on the relation between sulfur isotope ratios obtained for petroleum and evaporites in rocks of the same geological period.

The data are considered indicative of the kind of environment in which the petroleum was formed and of changes in sulfur isotope ratios of the sea throughout geological time. (C.H.)

15555 TENTH PACIFIC SCIENCE CONGRESS OF THE PACIFIC SCIENCE ASSOCIATION, HELD AT THE UNIVERSITY OF HAWAII, HONOLULU, HAWAII, U. S. A., 21 AUGUST-6 SEPTEMBER 1961. SYMPOSIUM ON ISOTOPES APPLICATIONS IN THE SOIL AND CROP SCIENCES. Intern. J. Appl. Radiation Isotopes, 13: 313-482(July-Aug. 1962).

Twenty-two papers from this symposium sponsored by the Food and Agriculture Organization of the United Nations are presented. Separate abstracts were prepared for only eleven papers. The other eleven papers deal with tracer techniques and pesticide and herbicide research. (T.R.H.)

15556 BIOLOGICAL AND AGRICULTURAL USES OF RADIOISOTOPES AND RADIATION. M. R. Zelle (Univ. of Washington, Seattle). Intern. J. Appl. Radiation Isotopes, 13: 319-23(July-Aug. 1962).

Applications of radioisotopes as tools in biological and agricultural research are reviewed briefly. It is pointed out that radioisotopes have made possible many significant experiments that formerly were impossible. Studies on carbon pathways in photosynthesis and studies of chromosome duplication using tritiated thymidine are cited as examples. Uses of radioisotopes in analytical techniques, tracer techniques, and radioautography are discussed. (C.H.)

15557 THE USE OF WETTING AGENTS IN FOLIAR NUTRITION. H. Boroughs and C. Labarca (Tropical Center of Research and Graduate Training, Interamerican Inst. of Agricultural Sciences, Turrialba, Costa Rica). Intern. J. Appl. Radiation Isotopes, 13: 359-64(July-Aug. 1962).

The addition of surfactants increased both absorption and subsequent translocation of P^{32}-labeled phosphates applied to the leaves of young coffee plants. The surfactants used included Fenopon-AC-78, Hyamine-2389, and Tween-80. The phosphate compounds included mono-ammonium, sodium, and potassium phosphates. Uses of foliar feeding in tropical regions with a large rainfall, where excessive leaching of fertilizer applied to soils occurs, are discussed. (C.H.)

15558 THE U. S. A. RESEARCH PROGRAM ON LOW-DOSE RADIATION PROCESSING OF FOOD. P. C. Aebersold and K. G. Shea (U. S. Atomic Energy Commission, Washington, D. C.). Intern. J. Appl. Radiation Isotopes, 13: 385-93(July-Aug. 1962).

Applications are discussed of low-dose radiation in the processing of fish and fruits to prohibit the growth of microbes and thus extend the marketing life of these highly-perishable products during shipment to remote areas. The research program of the U. S. Atomic Energy Commission on low-dose radiation processing of food is reviewed. (C.H.)

15559 THE USE AND LIMITATIONS OF ISOTOPES AND RADIATION STERILITY IN MEETING INSECT PROBLEMS. E. F. Knipling (U. S. Dept. of Agriculture, Beltsville, Md.). Intern. J. Appl. Radiation Isotopes, 13: 417-26(July-Aug. 1962).

Uses and limitations of radioisotopes in advancing entomology research and for insect control are reviewed. The possible use of radiomimetic chemicals in lieu of irradiation as a means of inducing sterility in insects, the use of radioisotopes in insect population and dispersal studies, the use of isotopes in insect physiology and biochemical studies, the use of isotopes in studies on resistance to insecticides and hazards to man associated with the use of insecticides, and the use of isotopes for irradiating insects to produce sexual sterility or to destroy the insects are discussed. (C.H.)

15560 PROGRESS OF FRUIT-FLY CONTROL BY IRRADIATION STERILIZATION IN HAWAII AND THE MARIANAS ISLANDS. L. F. Steiner, W. C. Mitchell, and A. H. Baumhover (U. S. Dept. of Agriculture, Honolulu, Hawaii). Intern. J. Appl. Radiation Isotopes, 13: 427-34 (July-Aug. 1962).

Results are reported from studies on the usefulness of the sterile-fly release method for eradication of the melon fly, Dacus cucurbitae, and the oriental fruit fly, Dacus dorsalis. Data from laboratory and field tests are summarized. (C.H.)

15561 INSECT CONTROL BY RADIATION STERILIZATION IN AUSTRALIA. D. F. Waterhouse (Commonwealth Scientific and Industrial Research Organization, Canberra, Australia). Intern. J. Appl. Radiation Isotopes, 13: 435-9(July-Aug. 1962).

The use of radiation for the production of sterile male insects and their use in insect control or eradication is discussed. Results are reported from the use of sterile males in the control of the Queensland fruit fly, Dacus tyroni, and the sheep blowfly, Lucilia cuprina, in Australia. (C.H.)

15562 THE USE OF IONIZING RADIATION FOR INSECT CONTROL IN LATIN AMERICA. H. Boroughs (Tropical Center of Research and Graduate Training, Interamerican Inst. of Agricultural Sciences, Turrialba, Costa Rica). Intern. J. Appl. Radiation Isotopes, 13: 441-3(July-Aug. 1962).

Applications of radiation for the control of the Mediterranean fruit fly, Ceratitis capitata, in Costa Rica are discussed. (C.H.)

15563 CONTRIBUTIONS OF RADIO-GENETICS TO PLANT BREEDING. E. A. Favret (Instituto de Fitotecnia, Castelar, Argentina). Intern. J. Appl. Radiation Isotopes, 13: 445-53(July-Aug. 1962).

Applications of radiation in plant breeding programs are reviewed. Topics discussed include the genetic effects of radiation in plants, the direct use of radiation or mutation breeding, indirect use of radiation based on the ability to produce chromosome breaks, and the mutagenic specificity of radiation in plants. (C.H.)

15564 PROGRESS REPORT ON THE STUDIES OF UTILIZATION OF X-RAY RADIATION FOR RICE IMPROVEMENT, 1961. H. W. Li, C. H. Hu, W. T. Chang, and T. S. Weng (Inst. of Botany, Academia Sinica, Tainan, Taiwan, China). Intern. J. Appl. Radiation Isotopes, 13: 455-65(July-Aug. 1962).

Mutations induced by x irradiation in 10 varieties of rice were used in breeding programs to increase the yield and disease resistance of rice plants. Results of field tests are reported through the X^3 generation. (C.H.)

15565 THE USE OF RADIATION-INDUCED MUTATIONS IN CROP BREEDING IN LATIN AMERICA AND SOME BIOLOGICAL EFFECTS OF RADIATION IN COFFEE. C. C. Moh (Tropical Center of Research and Graduate Training, Interamerican Inst. of Agricultural Sciences, Turrialba, Costa Rica). Intern. J. Appl. Radiation Isotopes, 13: 467-75(July-Aug. 1962).

Results are summarized from a study on the genetic effects of radiation in coffee as observed in R_1 plants grown from seeds exposed to x radiation, γ radiation, or thermal neutrons. A high frequency of morphological mutants was observed in the young plants. Possible reaction mechanisms involved in the induction of the mutants are discussed. (C.H.)

15566 REVIEW OF RESEARCH ON USE OF RADIATION-INDUCED MUTATIONS IN CROP BREEDING WITH SPECIAL REFERENCE TO RICE IN JAPAN. T. Matsuo (Tokyo Univ.). Intern. J. Appl. Radiation Isotopes, 13: 477-8(July-Aug. 1962).

Applications of radioinduced mutations in crop breeding programs are reviewed. Data are included from a 10-year study in Japan on improvement of crop yield and disease resistance through the use of radioinduced mutations of rice. (C.H.)

15567 THE INTERACTION OF YTTRIUM WITH CONSTITUENTS OF BONE AND OTHER COMPOUNDS. Jill Dearnaley (Churchill Hospital, Oxford). Intern. J. Radiation Biol., 6: 39-47(Jan. 1963). (In English)

The binding properties of yttrium with a variety of organic compounds were investigated using an ion-exchange resin. EDTA had the greatest affinity, then citrate, isocitrate, and malate, the binding being less at lower pH values. Serum albumin showed some binding, which decreased after hydrolysis with 6N HCl at 100°C. EDTA and citrate had far weaker chelating properties with Sr^{89} than Y^{91}. Extracts prepared from cortical beef-bone powder were found to possess only weak binding with yttrium, which decreased on dialysing the extract. If untreated bone powder was used in place of resin, the uptake of Y^{91} and Sr^{89} was less at the lower pH values. If the bone powder was ashed, Sr^{89}-uptake was unaffected, but Y^{91}-uptake was high at all pH values. It is suggested that citrate may be a factor determining the uptake of yttrium in bone. (auth)

15568 RELATIVE PROTECTION BY THE USE OF I^{132} AND I^{133} IN THE STUDY OF THYROID PATHOLOGY. M. De Roo (Cliniques Universitaires Saint-Raphael, Louvain, Belg.). J. Belge Radiol., 45: 698-703(1962). (In French)

In order to reduce the dose to the thyroid gland, the use of short half life isotopes of radioiodine was indicated. I^{132} allows a large, clinically valuable screening, the dose to the thyroid gland being negligible. A more thorough study of the thyroid physiopathology is possible with the aid of I^{133}, the dose to the critical organ being reduced to one third. Calculation of the doses to the thyroid gland and to the whole organism makes it possible to ascertain the importance of the radioiodine isotopes and the urgent necessity of their use from the point of view of protection. (P.C.H.)

15569 THEORETICAL CALCULATION OF THE INTEGRAL DOSE. COMPARISON OF TELE-CESIUM^{137} WITH TELE-COBALT^{60}. J.-M. Debois (Cliniques Universitaires Saint-Raphael, Louvain, Belg.). J. Belge Radiol., 45: 728-41(1962). (In French)

Integral dose tables were established for telecurie-therapy with the penumbra taken into account. The contribution of the penumbra was studied in detail. For what concerns the relation integral dose/tumor dose, telecesium-therapy can be situated between telecobalt- and 200-kv-therapy. (P.C.H.)

15570 RECOVERY OF OXIDATIVE PHOSPHORYLATION IN RAT LIVER MITOCHONDRIA AFTER WHOLE BODY IRRADIATION. James C. Hall, Allan L. Goldstein, and B. P. Sonnenblick (Rutgers Univ., Newark, N. J.). J. Biol. Chem., 238: 1137-40(Mar. 1963).

Mitochondria were isolated from the livers of rats exposed to a single acute dose (840 r) of whole-body irradiation at 1, 3, 6, 12, 24, 48, and 72 hours before they were killed, and from sham-treated controls. Mitochondrial protein fell to 75% of the control level within 6 hours after irradiation and returned to normal within 24 hours. The number of mitochondria decreased to some extent during the first 3 hours and then recovered, but the significance of these variations is questionable. Irradiated mitochondria show greater size variation and fragility. O_2 consumption varied considerably during the time period investigated. It was higher than the control rate with all four substrates 6 hours after irradiation, and returned to normal after 24 hours. The rate of synthesis of adenosine triphosphate was decreased by 20% after irradiation for 1 hour and remained at this lower level for 12 hours. It had returned to the control level by 24 hours in most cases and by 48 hours in all. P : O ratios were reduced by 25% 3 hours after irradiation and remained so for 12 hours. Control levels were reached with three substrates within 24 hours, but with glutamate only after 48 hours. (auth)

15571 STUDIES OF THE RETICULOENDOTHELIAL SYSTEM (RES). I. MEASUREMENT OF THE PHAGOCYTIC CAPACITY OF THE RES IN MAN AND DOG. Masahiro Iio and Henry N. Wagner, Jr. (Johns Hopkins Medical Institutions, Baltimore). J. Clin. Invest., 42: 417-26(Mar. 1963).

When human serum albumin is aggregated under standardized conditions, a polymer is obtained that can be successfully used to study the phagocytic capacity of the reticuloendothelial system (RES) in man. In addition to careful control of pH, temperature, amount of agitation, and concentration of the albumin solution, it is necessary to monitor the changes in optical density, to insure adequacy of the prepared material by bioassay in man, or dog, or both, and to conduct simultaneous control studies in normal subjects during the study of patients. Large doses of aggregated albumin can be safety administered over prolonged periods to human subjects without evidence of hypersensitivity or excessive radiation. The phagocytic capacity of the RES in both man and dog was determined experimentally with the analytical method of Michaelis and Menten. In man, this maximal rate of phagocytosis of aggregated albumin was 1.07 mg per minute per kg of body weight. (auth)

15572 STUDIES OF THE RETICULOENDOTHELIAL SYSTEM (RES). II. CHANGES IN THE PHAGOCYTIC CAPACITY OF THE RES IN PATIENTS WITH CERTAIN INFECTIONS. Henry N. Wagner, Jr., Masahiro Iio, and Richard B. Hornick (Johns Hopkins Medical Institutions, Baltimore and Univ. of Maryland, Baltimore). J. Clin. Invest., 42: 427-34(Mar. 1963).

The phagocytic capacity of the reticuloendothelial system (RES) was measured in patients with pneumococcal pneumonia, typhoid fever, sandfly fever, and tularemia. (auth)

15573 EFFECTS OF CORTISONE AND X IRRADIATION ON THE COURSE OF TRYPANOSOMA LEWISI INFECTION IN THE RAT. I. V. Herbert (Univ. of Nottingham School of Agriculture, Loughborough, Leics, Eng.) and E. R. Becker. J. Parasitol., 47: 304-8(1961).

Cortisone treatment of T. lewisi-infected rats did not cause inhibition of the production of Taliaferro's antibody albastin or of its maintenance. In fact, the duration of the infection may be diminished by cortisone. Cortisone at

the levels used, therefore, did not exert a deleterious effect on antibody production or maintenance in a similar manner to salicylate administration, previously reported. Neither cortisone nor lethal (800-r) x irradiation permitted reinfections of immune rats with massive doses of T. lewisi. Hence, the specific chemical groups or configurations responsible for maintaining antibody specificity were not x-ray sensitive at the doses administered. While x irradiation with 800 r failed to permit reinfections of immune rats with T. lewisi, it was established that the parasitemia in initial infections was greatly increased and frequently caused deaths of the infected animals. (H.H.D.)

15574 A RELIABLE AUTORADIOGRAPHIC TECHNIQUE. R. C. Curran and A. E. Clark (St. Thomas's Hospital Medical School, London). J. Pathol. Bacteriol., 82: 219-21(July 1961).

A stripping-film technique is described which is designed to avoid the 2 major faults of previous methods, namely, high background and drying-out of the medium so that the section becomes opaque. The tissue is fixed in 4% formaldehyde and hydrated sections are covered with a strip of photographic emulsion (Kodak AR 10 or AR 50). The autoradiographs are then dried in circulating air to remove all traces of moisture and the slides are stored at 4°C during the required exposure period. Prestraining the section, as is sometimes recommended in combination with dipping in celloidin solution, is avoided since this often diminishes detectable radioactivity. It may even give a negative result, particularly with soft β-ray emitters such as H^3, C^{14}, and S^{35}. Poststaining of the sections avoids this possible loss. A number of staining procedures are described for bringing out nuclear and fibrillar elements. Neutral red staining is recommended since it contrasts well with the black silver grains and permits detection of low levels of radioactivity. (H.H.D.)

15575 EVALUATION OF BORON COMPOUNDS FOR USE IN NEUTRON CAPTURE THERAPY OF BRAIN TUMORS. I. ANIMAL INVESTIGATIONS. A. H. Soloway, R. L. Wright, and J. R. Messer (Massachusetts General Hospital, Boston). J. Pharmacol. Exptl. Therap., 134: 117-22(Oct. 1961).

Ten boron compounds were compared with each other and with boric acid to ascertain which compounds deserved additional study on the basis of tumor:brain ratios and toxicity in mice with subcutaneously transplanted gliomas. Of those screened, the most satisfactory from toxicity considerations were: m-boronosuccinanilic acid, 3-amino-4-carboxybenzeneboronic acid, 2-acetamidobenzene-1,4-diboronic acid, o-(2-carboxy-2-acetamidoethyl)-benzeneboronic acid, and sodium perhydrodecaborate. Three were investigated more extensively in larger animals and in terminal glioma patients. Sodium perhydrodecaborate in doses of 50 mg B/kg were administered to man with no untoward effects. Intravenous injections of 3-amino-4-carboxybenzeneboronic acid were well tolerated by cats. Kidney and scalp had high boron concentrations whereas in normal brain it was low. Injection of m-boronsuccinanilic acid in a dose of 86 mg B/kg via the carotid artery produced a marked alteration in the EEG together with respiratory arrest, which failed to respond to assisted respiration. Doses of 40 mg B/kg, however, were well tolerated by both intravenous and intracarotid routes. Normal brain showed a very low content of either agent independent of the route of administration. (P.C.H.)

15576 9 YEARS OF SUPERVOLT THERAPY, A REPORT ON THE EXPERIENCES OF THE TUMOR INSTITUTE OF THE UNIVERSITY OF TEXAS IN HOUSTON. H. Kuenlen. Med. Klin. (Munich), No. 3, 93-8(1963). (In German)

Comparative reports were made on the results of orthovolt (250 kv) and supervolt therapy (cobalt cannon and ultrahard x radiation of a 22-Mev betatron) of tumors of the cervix uteri, bladder, and oral cavity. The comparison of the 5-year survival quota showed the superiority of the high volt therapy. Other advantages, such as improved tolerance, skin protection, and possibility for the application of higher site doses with extensive protection of the surrounding healthy tissue were indicated. These results depend partially on personal information or to publications which are difficult to obtain in Germany. (tr-auth)

15577 ERYTHROKINETIC STUDIES IN THE DIAGNOSIS OF ANEMIC STATES. R. Gevirtz, C. Collica, and P. A. Miescher (New York Univ., New York). Med. Klin. (Munich), No. 36, 1515-20(1962). (In German)

The most important methods for the functional isotopic diagnosis for the diagnosis of anemic states were shown using some clinical analysis. In the frequently occurring hyperspleen syndrome and in the hemolytic anemia, it is important with reference to indications for splenectomy to know the splenic contribution to the pathological erythroclasis. If disturbances in the hematopoietic system and in the elimination of erythrocytes are simultaneously present, as, for example, in osteomyelofibrosis or in aplastic anemia with pathological linear erythrocyte destruction, it is important for the therapeutic determination to receive as complete a picture as possible of the ferro-kinetic and erythrokinetic situation. Ferro- and erythrokinetic investigations have an important position in the clinical use of the mechanisms underlying anemia, as was shown using pernicious anemia as an example. With the indication on the new possibilities in hematological diagnosis, by the introduction of radioisotopes in the clinic, a warning was given against their random use. As in all radiobiological investigation methods, a strong indication must be present and when a complete clarification is possible with simpler means, isotope studies should be avoided. (tr-auth)

15578 CHEMICAL DETERMINATION OF THE ISODOSE CURVE IN A Co^{60} SOURCE "HOT SPOT Mk IV" OF 2000 CURIES DONATED TO THE PERUGIA ZOOPROPHYLACTIC INSTITUTE. A. Begliomini and D. Massa (Istituto Zooprofilattico dell'Umbria e delle Marche, Perugia, Italy). Minerva Nucl., 6: 343-7(Nov. 1962). (In Italian)

A 2000 Co^{60} Hot Spot Mk IV unit whose isodose curves were determined by the ferrous sulfate technique is described. The dose in the center of the chamber (8 cm × 14 cm) was about 500,000 rads/hr. Taking this figure to represent 100% of the dose, a 5% increase in the dose was found 1.5 cm from the center of the chamber laterally. The value increases from the center to the walls of the chamber. However, about 4 cm from the center of the chamber, proceeding toward its base, the value decreased 5%, and decreased progressively still more as measurements were made gradually nearer to the base. A table is presented from which the correction factors for Co^{60} decay rate can be calculated. (auth)

15579 SYNTHESIS OF ORGANIC COMPOUNDS BY ELECTRIC DISCHARGES. J. Oró (Univ. of California, Berkeley and Univ. of Houston, Tex.). Nature, 197: 862-7(Mar. 2, 1963).

Prolonged electric spark discharges were applied to mixtures consisting essentially of methane, ammonia, water, and ethane in an investigation of the synthesis of organic compounds under possible primitive earth condi-

tions. C^{14}-hydrocarbons, mainly C^{14}-methane, were used as tracers. Radioautograms were prepared of two-dimensional chromatograms of the products formed. The results show that a number of organic compounds are formed by the action of electric discharges on the mixtures. The products obtained include glycine, alanine, aspartic acid, asparagine, isoleucine, glycinamide, and possibly proline, a yellowish oil, a highly insoluble polymer, and several ultraviolet-absorbing compounds. Products that gave purple, green, and brown derivatives with ninhydrin, suggesting the presence of amines, amino-nitriles, amino-amides, and peptides, were also formed. The experimental procedure is described. (C.H.)

15580 MEASURING BRAIN BLOOD FLOW WITH RADIOISOTOPES. W. H. Oldendorf (Veterans Administration Center, Los Angeles). Nucleonics, 21: No. 4, 87-90(Apr. 1963).

A method was developed for measuring the absolute flow of blood through the brain using I^{131}. In this method, the venous system of the arm is distended, an I^{131}-labeled salt of hippuric acid is injected while circulation is completely cut off, and the obstruction is released suddenly to propel the activity into the right heart. The activity flowing through the brain is measured with a two-NaI crystal system and plotted versus time; the first derivative of the activity curve gives a positive and a negative peak, and the time interval between the peaks is the mean transit time of the blood. The absolute flow can be calculated from this transit time and the brain blood volume. (D.L.C.)

15581 ISOTOPIC EXCHANGE IN SOIL FERTILITY STUDIES. C. G. Lamm, E. H. Hansen, and J. A. Joergensen (Technical Univ. of Denmark, Copenhagen). Soil Sci., 95: 16-23(Jan. 1963).

Isotopic exchange is a very useful tool in soil fertility evaluations. Under given conditions, the rate of isotopic exchange of a nutrient between the solid and liquid phase of the soil-solution system is correlated with the rate of desorption of the nutrient from the solid phase. Isotopic exchange reactions depend on the crystal structure and the surface area of the solid compound, on the nature of the chemical bond, on chemical reactions involved in the exchange, and on the experimental conditions. Provided there is no chemical isotopic effect between the labeled and unlabeled atoms, isotopic exchange reactions will occur in systems where chemical equilibrium is already established. Desorption reactions also depend on the above factors as well as on the concentration in the liquid phase, but they only take place in systems where chemical equilibrium is not established. (auth)

15582 RADIOISOTOPE SCANNING IN THE DETECTION OF PERICARDIAL EFFUSIONS. Frederick J. Bone, Giles J. Andrews, Ernest A. Elmendorf, Norman L. Presley, and Jack S. Krohmer (Texas Southwestern Medical School, Dallas). Southern Med. J., 55: 577-80(June 1962).

The development of a new method for scintillation detection of pericardial fluid is described. A model system is used in which heart and pericardium are simulated by a pair of readily distensible rubber balloons, one inside the other. Radioisotope scintillation scanning of the blood pools of the heart can best be performed by employing a scanning apparatus which affords a large, well-shielded thallium-activated NaI crystal, a focusing collimator, and a cathode-ray tube photographic printing system with circuits for modifying contrast and density. The 74 min biologic half life of I^{131}-labeled iodipamide (Cholografin) reduces greatly the radiation dose delivered to the patient and permits using tracers of the order of 750 μC, increasing the number of counts in the area of interest. (P.C.H.)

15583 RADIATION PASTEURIZATION. B. S. Schweigert (Michigan State Univ., East Lansing). Texas State J. Med., 57: 914-16(Nov. 1961).

A review. (H.H.D.)

15584 SUPPRESSION OF THE HOMOGRAFT RESPONSE BY PRETREATMENT WITH ANTITUMOR AGENTS. Stewart R. Humphreys, John P. Glynn, and Abraham Goldin (National Cancer Inst., Bethesda, Md.). Transplantation, 1: 65-9(Jan. 1963).

A system is described which may be employed for screening agents which suppress the immune response. The test is based on the suppression of the homograft response to leukemia L1210 and resistant sublines in pretreated C57BL mice. The alkylating agents (Cytoxan, triethylene melamine, and Melphalan) and x irradiation exhibited marked activity in this system. 6-Mercaptopurine was moderately effective and amethopterin was relatively inactive. (auth)

15585 HISTOINCOMPATIBILITY ASSOCIATED WITH THE X CHROMOSOME IN MICE. Donald W. Bailey (Univ. of California, San Francisco). Transplantation, 1: 70-4 (Jan. 1963).

The rejection of skin grafts between reciprocal hybrid type male mice can most simply be explained by histocompatibility genes on the X or Y chromosome. The acceptance of such grafts between females rules out maternal cytoplasmic influences. The evidence shows that it is the skin of the paternal strain, the carrier of the contrasting X chromosome, and not the skin of the maternal strain, the carrier of the contrasting Y chromosome (when the maternal strain males were used as donors) that is rejected by the hybrid male. This result indicates that the X chromosome is the carrier of one or more factors determining histoincompatibility. No evidence was found that the Y chromosome played a part in the rejections. (auth)

15586 ISOTOPIC LABELING OF CORNEAL STROMAL CELLS PRIOR TO TRANSPLANTATION. Frank M. Polack (Columbia Univ., New York). Transplantation, 1: 83-96 (Jan. 1963).

The connective tissue cells in a large central area of the cornea were killed by freezing without apparent permanent damage to the optical properties of the cornea. The dead cells were replaced by mitosis and migration of the keratoblasts surrounding the injury. Injected H^3 thymidine was incorporated in the regenerating cells. The cells concerned with thymidine uptake were found in a ring-shaped band immediately adjacent to and surrounding the injury. Cells further removed from the injury in the corneal periphery did not participate in this process. Most DNA synthesis, as shown by tritiated thymidine uptake, occurred during the first few days but some DNA synthesis was demonstrable as late as 7 to 9 days after injury. When the depopulated zone decreased in diameter, as new cells moved inward, the ring of regenerating cells became smaller. After new cells formed in the regeneration zone they migrated into the depopulated area within a few days. The central cornea, after a few weeks, became filled with cells normal in number and appearance of which about 25% were demonstrably radioactive. The tritiated thymidine label, although diluted by cell division which occurred early in the regeneration process, persisted in these cells indefinitely. Such corneas appear to be ideal material for transplantation experiments in which the persistence of donor cells could be studied.

This has been accomplished in a series of preliminary experiments in which the indefinite persistence of the donor cells in corneal grafts was demonstrated. (auth)

Biochemistry, Nutrition, and Toxicology

15587 (CRER-1068) STRONTIUM, BARIUM AND CALCIUM IN SOME COMPONENTS OF HUMAN DIET. W. E. Grummitt and G. Lahaie (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 1963. 22p. (AECL-1680)

Procedures for the estimation of natural calcium, strontium, and barium are outlined. Results of the determination of these elements in the more important components of the Canadian diet are presented. Calcium was measured gravimetrically and strontium and barium were determined by neutron activation analysis. (auth)

15588 (LADC-5209) COMPARATIVE METABOLISM OF RADIOISOTOPES IN MAMMALS. II. RETENTION OF IODINE^{131} BY FOUR MAMMALIAN SPECIES. J. E. Furchner and C. R. Richmond (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract W-7405-eng-36. 31p.

Tracer doses of I^{131} were administered orally to rats, mice, dogs, and monkeys and intraperitoneally to rats and mice. The whole-body activities were measured for periods of 6 to 7 weeks. Three-component exponential equations describe I^{131} retention in rats and mice, and 2-component equations were adequate to describe I^{131} retention in dogs and monkeys. Small differences in retention and excretion after oral and intraperitoneal administration were noted in both rats and mice. Distribution studies in rats show the body burden to be equally distributed in thyroid and pelt. A parabolic relationship between body weight and estimated equilibrium level was used to estimate $(MPC)_w$ for man. (auth)

15589 (TID-18058) THE DEVELOPMENT OF CHELATING AGENTS FOR ENHANCING THE URINARY EXCRETION OF STRONTIUM. [Annual] Report No. 2, December 1, 1961–December 31, 1962. Harry Kroll, Kenneth Wunschel, and Vincent Elkind (Eltex Research Corp., Providence). Jan. 10, 1963. Contract AT(30-1)-2710. 23p.

A large scale synthesis of triethylenetetramine hexaacetic acid (TTHA) has been developed. The pentaethyl ester of diethylenetriamine pentaacetic acid was prepared for use in Sr^{90} decontamination studies in animals. Metal binding studies of the water soluble polyelectrolytes, sodium polystyrenesulfonate and sodium polyvinylsulfonate, were continued. A method for determining their apparent binding affinities for alkaline earths cations was developed. The application of these polyelectrolytes for inhibiting or preventing the in vitro absorption of radioactive isotopes was suggested. The syntheses of a group of phosphorous containing chelating agents are described. (auth)

15590 (TID-18161) RADIONUCLIDE CYCLING IN AGRICULTURAL PLANTS. Technical Progress Report, March 1, 1962 to February 28, 1963. (Minnesota. Univ., St. Paul. Inst. of Agriculture). Feb. 1963. Contract AT(11-1)-783. 90p.

Distribution of foliar applied Sr^{85} and P^{32} to the ears of corn was studied as a function of time of application, i.e., before, during and after silk. It was found that the uppermost two ears develop and mature in corn and that these ears have transported to them the greatest amount of radioisotope, regardless of leaf treated or time of application. Distribution of foliar applied Sr^{85} from the leaves of soybean to the fruit was studied as a function of the age of the plant. It was found that there was an increase in amount of Sr^{85} transported to the fruit with an increase in age of plant and subsequent fruit developed. Final distribution of foliar applied Sr^{85} in the fruits of soybeans and corn was studied. The pattern of movement is not very unlike that of a 24-hour uptake although certain differences are indicated. Uptake of Sr^{85} from Rosemount soil by soybean was studied and indicates an increased amount in older plants and an increased amount of that taken up appearing in the fruits. A contamination survey shows no appreciable contamination of the area surrounding the sites of radioisotope usage. (auth)

15591 ON THE UPTAKE OF RADIOACTIVE CALCIUM AND STRONTIUM IN THE SKELETON OF NORMAL AND RACHITIC RATS. H. Bohr (Orthopaedic Hospital, Copenhagen). Acta Orthopaed. Scand., 30: 237-50(1961). (In English)

The uptake of Ca^{47} and Sr^{85} given intravenously to normal and rachitic rats was followed by measurements of the activity of the tail and total body of living animals. During the first hours after injection, the total-body activity decreased slightly because of excretion of the radioisotopes, while the activity of the tail rose on account of their accumulation in bone. The uptake in bone the first hr after injection was the same in normal and rachitic rats, but in the rachitic rats it decreased within 8 hr to $\sim 1/2$ the maximum value. Besides the diffuse uptake of isotopes in the bone tissue itself, demonstrated in both the normal and the rachitic bone, a heavy accumulation of isotopes took place on the metaphyseal side of the epiphyseal line in the normal bone, but in the rachitic bone uptake was lacking. The results indicate that the immediate uptake of radioactive Ca and Sr in bone, as seen during the first hours in both normal and rachitic animals, is due mainly to a reversible exchange process, as shown by the decrease in the activity in the rachitic animals during the succeeding hours. Only part of the activity taken up at the epiphyseal line was retained by the skeleton by later accretion processes. Thus, 2 phases of incorporation of the isotopes must be considered: a rapid, reversible exchange between blood and bone tissue, and a secondary, slower incorporation in bone mineral. (H.H.D.)

15592 EFFECTS OF ALKALI HALIDES AND OTHER INORGANIC SALTS ON RADIATION INACTIVATION OF TAKA-AMYLASE IN AQUEOUS SYSTEM. Mitsuo Namiki, Yoshishige Okazawa, and Akira Matsuyama (Tokyo Univ.). Agr. Biol. Chem. (Tokyo), 25: 852-9(Nov. 1961).

The effects of various inorganic substances (NaCl, KCl, KBr, KI, NaClO, $NaClO_2$, $NaClO_3$, $NaClO_4$, $NaNO_2$, Br_2, and I_2) on radiation inactivation of solutions of taka-amylase A were investigated and compared with their synergistic action on the radiation inactivation of microorganisms. Effective concentrations of the halides giving protection against irradiation inactivation of the enzyme corresponded to those having a synergistic action on microorganisms. Removal of dissolved oxygen from halide solutions decreased their protective effect. Irradiated alkali halide solutions at high concentrations exhibited an inactivating action on the enzyme. Various types of addition effects of halogens and halogenoxyacids were observed with or without irradiation. $NaNO_2$ showed effective protection even with higher radiation doses, and the metal cations Cu^{2+} and Fe^{3+} also gave a protective action at low concentrations. It was concluded that alkali halides have a marked protective effect on radiation inactivation of taka-amylase in aqueous systems. Inactivation observed in irradiated

alkali halide solutions of relatively high concentrations indicated formation in the solutions of some compound injurious to the enzyme by irradiation. (P.C.H.)

15593 ASSOCIATION OF RADIOACTIVE CHROMIUM WITH VARIOUS COMPONENTS OF HEMOGLOBIN. Daniel Malcolm, Helen M. Ranney, and Alan S. Jacobs (Albert Einstein Coll., New York and Bronx Municipal Hospital, New York). Blood, 21: 8-20(Jan. 1963).

Normal hemoglobin labeled with Cr^{51} by incubation of whole blood with $Na_2Cr^{51}O_4$, or by incubation of hemolysates with either $Na_2Cr^{51}O_4$ or $Cr^{51}Cl_3$ and most of the Cr^{51} activity was associated with the electrophoretically rapid hemoglobin A_3. The formation of a Cr^{51}-hemoglobin complex with an isoelectric point lower than that of hemoglobin was thought to be the most likely explanation of this finding. The radioactivity of Cr^{51}-labeled hemolysates containing hemoglobin S, C, and A was found to be associated with the more rapid electrophoretic components. This supports the hypothesis of a lower isoelectric point of a Cr-hemoglobin complex. The association of Cr^{51} activity with polypeptide chains of hemoglobin was also studied. Cr^{51} was found in both the naturally occurring β chain component (hemoglobin H) and in the β chain component. This supports the hypothesis that β chains of hemoglobin have a greater affinity for Cr than do α chains. (P.C.H.)

15594 RADIATION TOLERANCE DOSE OF THE OVARIES. Heinrich Martius (Krankenhause Neu-Bethlehem, Göttingen, Ger.). Deut. Med. Wochschr., 86: 888-90(May 5, 1961).

On the basis of examinations of histopathologic changes in irradiated human ovaries and animal experiments, it was concluded that there is no threshold radiation dose for the ovaries. Even minimal doses, which are exceeded during radiologic procedures, cause damage to ovarian follicles. All absorbed ionizing radiations are potentially mutagenic and their action can be expected to exceed that of the natural, spontaneous mutagenic factors. Since the vast majority of radioinduced mutations will be lethal or of a recessive nature, their actual observed incidence does not accurately reflect their frequency. If it is considered that a single ionized particle is required to induce a mutation, it is evident that there can be no threshold or tolerance dose. It is also pointed out that the cumulative effects of radiation in subsequent generations of human beings can hardly be extrapolated from short-term experiments in mice and that conclusions based on these experiments are of limited value for man. In certain developmental stages, the ovum is highly radiosensitive so that it is necessary to consider the risk of injuring it rather than to consider a tolerance dose. The risk will have to be weighed against the possible benefits of diagnostic radiology or radiotherapy in each case. (H.H.D.)

15595 THE SYNTHESIS OF FATTY ACIDS BY RAT LIVER SLICES IN TRITIATED WATER. Daniel W. Foster and Ben Bloom (National Inst. of Arthritis and Metabolic Diseases, Bethesda, Md.). J. Biol. Chem., 238: 888-92 (Mar. 1963).

Long chain fatty acids from rat liver slices were isolated after incubation in a medium enriched with tritiated water. The saturated fatty acids were separated by lead salt precipitation and the incorporation of radioactivity into the individual acids determined. The major portion of radioactivity was found in palmitic and stearic acids. Sequential degradation of the saturated fatty acids was carried out and the intramolecular location of tritium determined. Contrary to expectation, more tritium was found in the odd-numbered carbon atoms than the even-numbered. It is suggested that an exchange reaction between reduced triphosphopyridine nucleotide and water occurs before or during fatty acid synthesis, and that the exchange is essentially complete. (auth)

15596 THE USE OF RADIOAUTOGRAPHY AND ELECTRON MICROSCOPY FOR THE LOCALIZATION OF TRITIUM LABEL IN BACTERIA. R. P. Van Tubergen (Rockefeller Inst., New York). J. Biophys. Biochem. Cytol., 9: 219-22(Jan. 1961).

The localization of DNA labeled with thymidine-H^3 was studied in Escherichia coli by electron microscopic examination of radioautographs of the cells using a thin film of Kodak V-1055 x-ray emulsion. In this way it was possible to localize the labeled DNA in whole bacteria to regions $<1\ \mu$ in length and $<\frac{1}{2}\ \mu^2$ in area. When cells of E. coli 15 T^- were labeled with thymidine and allowed to grow for 3 generations, $\sim\frac{1}{2}$ the cells showed radioactivity. Electron micrographs of such radioautographed cells showed the silver, ribbon-like grains, and the bacteria were also clearly visible. It was noted that labeling was present in only half of a cell, in cell regions $<1\ \mu$ in length. Over $\frac{1}{3}$ of the labeled 3rd generation cells showed this particular localization. Approximately $\frac{1}{3}$ of the labeled cells showed a concentration of grains in the central region while less than $\frac{1}{3}$ showed a random grain pattern. In contrast, fully labeled cells showed a consistently random grain pattern. This demonstration of the localization of each DNA structure in $\frac{1}{2}$ of the cell supports the view that the chromosomes in E. coli are haploid, 2 in number, and physically separated. The results also showed that, by using Kodak V-1055 emulsion, electron microscopy and radioautography can be simply combined for examining tritium-labeled bacteria. The localization of label to areas of the order of less than $\frac{1}{2}\ \mu^2$ thus enables the examination of high specific activity, tritium-labeled biological preparations. (H.H.D.)

15597 ANGIOTENSIN LABELED WITH I^{131} AND WITH TRITIUM. Benjamin H. Barbour and Frederic C. Bartter (National Heart Inst., Bethesda, Md.). J. Clin. Endocrinol. and Metab., 23: 313-14(Mar. 1963).

An analysis was made of I^{131}- and tritium-labeled angiotensin. It was found that both undergo loss of biological potency. It was assumed that during and after iodination there is breakdown of the polypeptide molecule. (P.C.H.)

15598 EXPERIMENTAL BERYLLIOSIS. I. EFFECTS OF A SINGLE INTRADERMAL INJECTION OF BERYLLIUM NITRATE INTO GUINEA PIGS. Barnet M. Levy and George M. Higgins (Univ. of Texas, Houston). J. Invest. Dermatol., 37: 175-82(Sept. 1961).

Changes induced in the skin of young guinea pigs by the intradermal injection of 0.05 ml of a 1% solution of beryllium nitrate are reported. The initial reaction to injected beryllium was an acute inflammatory one, reaching at the end of the second day from the epithelium through the dermis into the subcutaneous tissues and involving the deeper musculature. The initial reaction was progressive, so that chronic inflammatory changes, involving an intense fibroplasia and fibrosis, followed. Four weeks after injection, a generalized granuloma extended from the basal layer through the dermis into the deeper subcutaneous and muscular tissues. Hair follicles and sweat glands were almost entirely destroyed. In excised areas of skin injected 6 months before, extensive granulomatous reactions persisted. Polymorphonuclear leukocytes dominated the early cytologic patterns in the guinea pig, followed in a week by migrating lymphocytes and active phagocytic histiocytes.

Later, there was an influx of fibroblasts with a resulting marked fibroplasia. The cytologic reaction to Be also included development of large mononuclear and multinucleated macrophages containing granules which were strongly PAS-positive. (P.C.H.)

15599 BIOLOGICAL EFFECTS OF THE DECAY OF INCORPORATED RADIOACTIVE PHOSPHORUS IN TRANSFORMING DEOXYRIBONUCLEATE. Maurice S. Fox (Rockefeller Inst., New York). J. Mol. Biol., 6: 85-94(Jan. 1963).

Transforming DNA was isolated from pneumococci that had grown for many generations in a medium containing very high specific activities of P^{32} as orthophosphate. As a consequence of the disintegration of the unstable P isotope by β decay to become sulfur, such DNA loses transforming activity. From an examination of the rates at which transforming activity is lost, it was possible to set some limits on the size of the functional elements in transforming DNA and the physical distance between genetically linked elements. As a lower limit, 900 nucleotide pairs were estimated as the size of the entity that must remain intact for the retention of biological activity. The rates of inactivation of linkage groups showed that a lethal event in 1 member of a linkage group has little or no effect on the activity of the other member or members of the linkage group. In addition, it appeared that P^{32} disintegrations between markers in a linkage group do not destroy linkage. (P.C.H.)

15600 RADIOIODINE UPTAKE STUDIES IN NEWBORN INFANTS. R. T. Morrison, J. A. Birkbeck, T. C. Evans, and J. I. Routh (Univ. of Iowa, Iowa City). J. Nucl. Med., 4: 162-6(Mar. 1963).

Seventeen newborn infants receiving intramuscular radioiodine had a mean maximal thyroidal uptake of 70% at 25 hours. Eight newborn infants receiving oral radioiodine had a mean uptake of about 45 per cent at 25 hours and a mean maximum uptake of about 50 per cent at 30 hours. The mean value of the maternal serum protein bound iodine was 9.8 ± 2.3 (S.D.) μg per cent. The mean value of serum protein bound iodine of cord blood was 8.6 ± 1.5 (S.D.) μg per cent. The mean value of the erythrocyte uptake of I-131 labeled triiodothyronine was 10.1 ± 1.3 (S.D.) per cent. (auth)

15601 THE PREPARATION OF TRITIUM-LABELED NORMORPHINE AND ITS PHYSIOLOGICAL DISPOSITION IN DOG AND MONKEY. A. L. Misra, H. I. Jacoby, and L. A. Woods (Univ. of Michigan, Ann Arbor). J. Pharmacol. Exptl. Therap., 132: 311-16(June 1961).

The preparation of nuclear tritium-labeled normorphine was carried out. About 1.2 g of finely divided normorphine hydrochloride was exposed to 12 C of tritium gas for 21 days at 27°C and 0.39 atm pressure. The crude product, which had a specific activity of 684 μc/mg, was dissolved in 10 ml hot distilled water in a centrifuge tube, and decolorized by Darco G-60. The light brown supernatant solution was basified with dilute NH_4OH to pH 9 and cooled. The precipitated crystals were removed, washed with ice-cold water, and dried in vacuo. The dried product was recrystallized from hot absolute methanol and then dissolved in 20 ml of a 1% NaOH solution; the solution was acidified with acetic acid and then basified with dilute NH_4OH. The crystallization, washing, and drying were repeated to give a granular light brown powder (950 mg, specific activity ~131.8 μc/mg). Plasma levels of free and conjugated normorphine-H^3 in the dog and monkey after subcutaneous injection of 2 mg/kg of drug are also reported. (P.C.H.)

15602 THE PREPARATION OF TRITIUM NUCLEAR-LABELED MORPHINE AND EVIDENCE FOR ITS IN VIVO BIOTRANSFORMATION TO NORMORPHINE IN THE RAT. A. L. Misra, S. J. Mulé, and L. A. Woods (Univ. of Michigan, Ann Arbor). J. Pharmacol. Exptl. Therap., 132: 317-22(June 1961).

The preparation of tritium nuclear-labeled morphine was conducted using normorphine base, obtained from crude tritium nuclear-labeled normorphine hydrochloride. This was converted to morphine using nonradioactive paraformaldehyde. The morphine thus obtained showed a single radioactive peak on chromatograms developed by 3 solvent systems. Radiochemically pure tritium nuclear-labeled morphine was obtained by the use of descending chromatography on large Whatman 3 MM sheets, buffered with 0.2M phosphate buffered pH 7.0. The sheets were developed simultaneously with a solvent mixture of tert-amyl alcohol, n-butyl ether, and water. In rats injected with morphine-H^3, 25% was recovered as urinary free morphine and 14% as conjugated morphine; ~74% of the administered radioactivity was recovered in urine. Evidence from paper chromatographic experiments was obtained for the in vivo biotransformation of morphine to normorphine by the rat, some of the normorphine appearing as a conjugate. (P.C.H.)

15603 THE CONCENTRATION OF COMMON CESIUM AND RUBIDIUM IN HUMAN BODY. Noboru Yamagata (Inst. of Public Health, Tokyo). J. Radiation Res. (Japan), 3: 9-30(Mar. 1962). (In English)

Measurements were made of K, Rb, and Cs in the human soft tissues, muscles, and bones from autopsies to determine the normal concentrations of the elements and to estimate the total body amount. The individual variability of concentration increased in the following order: K, Rb, Cs and the distribution pattern of K in muscle suggest a normal distribution and the observed distribution of stable Cs and the Cs/K ratio in muscle appear to be lognormal. The amount of K, Rb, and Cs in the total body estimated from the concentrations of these elements in the soft tissues, muscle, and bone was, respectively, 136 ± 28, 0.36 ± 0.09, and 1.4×10^{-3} grams, (95% probable range: $0.50 - 4.1 \times 10^{-3}$) for the standard man of 70 kg body weight. (P.C.H.)

15604 STUDY ON ABUNDANCE OF RARE EARTH ELEMENTS IN MARINE ORGANISMS. Kazuhisa Kameda (Japan Atomic Energy Research Inst., Tokyo). J. Radiation Res. (Japan), 3: 89-103(June 1962).

The abundance of rare earth elements in marine organisms was determined by activation analysis. The La content in bone, scales, shell, gills, and dorsal fins of fish was found to be 10^{-5} to 10^{-7} g/g of wet weight; the internal organs such as the stomach, heart, and intestines were 10^{-8} g/g (wet); and the muscle showed the smallest value, 10^{-9} g/g (wet). Other rare earth elements, Pr, Sm, Eu, Dy, and Ho were also found in marine organisms. The general trend of most of the rare earth elements in marine organisms is toward concentrating in the bone structure. (auth)

15605 CONTAMINATION OF MILK BY RADIOIODINE. Ann Johnson and E. Eric Pochin (University Coll. Hospital Medical School, London). Lancet, 2: 1097-8(Nov. 11, 1961).

To show the speed and completeness with which oral iodides in pharmacological dosage inhibit further radioiodine uptake, the length of time during which thyroid iodine uptake continues to be depressed following such a dose was studied. Thyroid uptakes were measured by profile counting methods at 3 hr after an oral test dose of I^{132}, before a 200-mg oral dose of stable iodide, and at various intervals after it. Preliminary data on 3 subjects are consistent in showing that the uptake is small at 1 day after iodide, is still only about 20% of normal at 2 days, but has returned to about 50% of normal at 3 to 4 days after the dose. It would seem, there-

fore, that doses every few days, rather than a single dose, would be required to suppress thyroid uptake of radioiodine during any prolonged period of high milk contamination with I^{131}. There is some evidence suggesting a faster iodine turnover in children than adults; this indicates a need for more frequent and perhaps daily doses if I^{131} uptake is to be kept at a low value. (P.C.H.)

15606 STRONTIUM-90: RESEARCH ON DANGEROUS "HOT ZONES" IN THE HUMAN SKELETON. C. Cappadona (Università, Palermo, Italy). Minerva Nucl., 6: 369-71 (Dec. 1962). (In Italian)

Human bones were analyzed in order to determine possible Sr^{90} "hot areas." Apparently exceptional concentrations were found in some cases. The feet and hands were the parts of the skeleton most contaminated. The subjects studied consisted of a boy and a number of stillborn anencephali. Further studies on the transfer of Sr^{90} from the mother to the child are being carried out in collaboration with biology centers. (auth)

15607 STUDY OF THE QUANTITATIVE GRANULOPOIETIC CAPACITY OF THE RETICULO-ENDOTHELIAL SYSTEM INVESTIGATED BY MEANS OF RADIO-GOLD COLLOIDS. V. Diomede-Fresa, D. Giordano, and S. Salamanna (Università, Bari, Italy). Minerva Nucl., 6: 391-4 (Dec. 1962). (In Italian)

A study was made on 26 rats of the quantitative distribution of Au^{198} injected by the intracardiac route. Particular attention was paid to the uptake values recorded in the bone marrow by means of the concentration index. Marrow uptake was found to be fairly high, although less than that of the liver, spleen, and thymus, with a concentration of 1.81 (compared with 13.65 for the liver). (auth)

15608 BEHAVIOR OF ELECTROPHORETIC PATTERNS AND BIOLOGICAL HALF-LIFE OF Au-198 INJECTED INTRAVENOUSLY INTO THE RABBIT. D. Giordano, P. De Rinaldis, and S. Salamanna (Università, Bari, Italy). Minerva Nucl., 6: 395-7(Dec. 1962). (In Italian)

A study was made of the biological behavior of radioactive colloidal gold injected intravenously into rabbits. After 1 minute and 47 seconds 50% of the substance was found in the circulation and after 5 minutes, 10%. Radioactivity was related to plasma protein fractions, in particular the α_1 globulins, as was demonstrated by autoradiography and even more clearly by electrophoresis. (auth)

15609 RADIOACTIVITY IN LARGE MARINE PLANKTON AS A FUNCTION OF SURFACE AREA. Charles Osterberg, Lawrence Small, and Lyle Hubbard (Oregon State Univ., Corvallis). Nature, 197: 883-4(Mar. 2, 1963).

Radioisotopes from Hanford reactors and from fallout are available to marine organisms in the north-east Pacific Ocean. The radioactivity in large marine plankton was measured as a function of surface area. Data are included from measurements of the content of K^{40}, Zn^{65}, Zr^{95}, Nb^{95}, Ru^{103}, Ru^{106}, Cr^{51}, and Ce^{141} in two species of pelagic crustaceans of different size taken from the same sample. Comparisons were also made between large adult and small adult or juvenile Euphausiids. The radioactivity of internal organs and external body parts was compared in the pelagic tunicate, Salpa. Results led to the conclusion that surface adsorption plays a relatively insignificant part in the accumulation of these radioisotopes by macroplankton. (C.H.)

15610 UPTAKE OF STRONTIUM BY ROOTS OF ZEA MAYS. Raymond Handley and Roy Overstreet (Univ. of California, Berkeley). Plant Physiol., 38: 180-4(Mar. 1963).

The absorption characteristics of vacuolated and non-vacuolated sections of the primary root of Zea mays L. with respect to the uptake of Sr were determined. Like Na, Ca, and Cl, uptake of Sr is a non-metabolic process in the meristematic portion of the root tip, but dependent upon metabolism in the vacuolated tissue. The data presented suggest the existence of a barrier probably lying close to the cell surface which normally limits the non-metabolic uptake of Sr. This barrier is apparently metabolically maintained and is readily destroyed by anaerobiosis, permitting larger amounts of Sr to enter the tissue. $SrCl_2$ was found to stimulate the respiration of both vacuolated and non-vacuolated tissue. (auth)

15611 A NEW METHOD FOR ESTIMATING HEPATIC CLEARANCE WITH THE SIMULTANEOUS USE OF ^{131}I-ROSE BENGAL AND COLLOIDAL ^{198}Au. Kiyoshi Miyai and Yuichi Kumahara (Osaka Univ.). Radioisotopes (Tokyo), 11: 306-17(Aug. 1962). (In Japanese)

The "parenchymal" and mesenchymal" hepatic clearances are measured simultaneously, by simultaneous administration of I^{131} and Au^{198}. The hepatic uptake of the two nuclides (which are carried in rose bengal and a colloid, respectively) is measured by means of a 2-channel analyzer and a scintillation detector. Results on normal livers, livers with cirrhosis, and livers with Banti's syndrome are noted. The utility of this method for analyses of liver function is discussed. (T.F.H.)

15612 STRONTIUM-90 IN HAIR. B. J. Hopkins, L. W. Tuttle, Walter J. Pories, William H. Strain (Univ. of Rochester, N. Y.). Science, 139: 1064-5(Mar. 15, 1963).

The hair of rats injected with strontium-90 retains a significant amount of the radionuclide. Although the strontium-90 content of hair is variable in these rats and appears to be subject to a variety of influences, determination of the radionuclide content of hair may offer a nondestructive method of estimating strontium-90 in bone. (auth)

15613 INFLUENCE OF LIMING AND MINERAL FERTILIZATION ON PLANT UPTAKE OF RADIOSTRONTIUM FROM DANISH SOILS. A. J. Andersen (Danish Atomic Energy Commission, Roskilde). Soil Sci., 95: 52-9(Jan. 1963).

The uptake of radioactive strontium by rye grass and red clover was studied in pot experiments, using 20 typical Danish agricultural soils. Comparisons were made between the effects of adding Ca in the form of carbonate, sulfate, and chloride, and the respective Mg compounds on Sr uptake by plants grown on three different soils. The influence of nitrogen and potassium application on uptake of Sr^{90} by oats was studied for two different soils. The results showed conclusively that in red clover the uptake of radioactive strontium was much greater than in rye grass. The uptake from the different soils decreased with increasing amounts of exchangeable Ca. Adding $CaCO_3$ at 2.5 tons/ha showed little effect on Sr uptake. However, heavy amounts of $CaCO_3$, at 5 and 10 tons/ha, reduced Sr^{89} concentration of the plants by 15 to 30 per cent, depending on the type of soil. $CaSO_4$ application showed little effect, and $CaCl_2$ increased Sr^{89} concentration of plants. The Sr^{89}/Ca ratio in plants could be reduced by the three different Ca compounds, the reduction being most effective when the carbonate was used. Mg as carbonate or sulfate proved more effective in reducing Sr^{89} concentration than did the corresponding Ca compounds. An increase in Sr^{89} concentration of plants followed the application of $MgCl_2$. Nitrogen fertilization increased yield and Sr^{90} concentration of straw, but lowered Sr^{90} concentration in grain. The concentration of Sr^{90} and Ca decreased with increasing amounts of added K, leaving the Sr^{90}/Ca ratio of the crops unaffected. (auth)

Fallout and Ecology

15614 (A/AC.82/G/L.810) FALLOUT IN NORWEGIAN MILK IN 1961. T. Hvinden, L. Lund, and P. Thoresen (Norway. Forsvarets Forskningsinstitutt, Kjeller). Sept. 28, 1962. 18p. (FFIS-IR-S-15)

The Sr^{90}, Cs^{137}, and I^{131} contents in Norwegian milk were determined in samples from 11 localities during 1961. The pattern for Sr^{90} and Cs^{137} concentration in milk for this period follows previously developed patterns of high values in summer months and lower values during remainder of year. The I^{131} concentration in milk shows a relatively steep rise in Sept. 1961 after the start of Soviet tests, falling off at end of October, at the beginning of the indoor feeding season for cows. The amount of fallout in milk has shown a decreasing tendency during the bomb test moratorium 1958 to 1961, but high summer values continued to show up in 1961. Results of measurements in tables and curves are presented. (H.G.G.)

15615 (BIO/06/62) DATA ON ENVIRONMENTAL RADIOACTIVITY COLLECTED IN ITALY, JULY–DECEMBER 1961. (Italy. Comitato Nazionale per l'Energie Nucleare, Rome). Apr. 1962. 402p. (A/AC.82/G/L.809)

A listing of data on environmental radioactivity collected in Italy during July to December, 1961 is presented. The data were categorized as follows: 44 stations collected samples for the determination of β radioactivity in the air at ground level; 32 stations collected samples for the determination of β radioactivity deposited by fallout on the ground; 37 stations collected samples of geographical and drinkable waters for the determination of β radioactivity; 5 stations collected samples of fallout for the analysis of fission product content; 12 stations collected samples of geographical and drinkable waters for the analysis for fission product content; 18 stations collected samples of milk for the analysis of Sr^{89}, Sr^{90}, Cs^{137}, and I^{131} content; and 7 stations collected various samples of soil, grass, vegetables, cereals, animal bones, human bones, cheese, etc. for the determination of various nuclides. (H.G.G.)

15616 (JPRS-18391) MEASUREMENT OF RADIOACTIVITY AT THE CZECHOSLOVAK WATER WORKS LABORATORIES COMPARED WITH FOREIGN MEASUREMENT TECHNOLOGY. J. Pavdernik. Translated from Isotopen Tech., 2: 341-3(Nov. 1962). 8p. (OTS-63-21435)

The Czechoslovakia Water Works employ extremely sensitive and accurate methods to measure non-continuous overall β-activity and radium content of water, using uncomplicated instruments. The basic principles of measuring water radioactivity, established by the CSSR Academy of Sciences, are used. A description of the methods used and comparison with other principles of radioactivity measurement are presented. (H.G.G.)

15617 AN ESTIMATE OF DECONTAMINATION FACTORS FOR THE DRAINAGE AREA OF THE VISTULA RIVER. R. Szepke (Central Lab. for Radiological Protection, Warsaw). Atompraxis, 9: 1-2(Jan. 1963). (In English)

Calculations showed that only about 1% per year of the annual radioactivity deposited in the Vistula River drainage area is removed by the river to the Baltic Sea. (auth)

15618 CARBON-14 IN A BIOLOGICAL ENVIRONMENT. I. ANNUAL VARIATION OF CARBON-14 CONCENTRATION IN THYMOL. Yoshiko Kasida, Mikio Yamazaki, Tetsuo Iwakura, Naoko Maginu, and Joju Haginiwa (National Inst. of Radiological Sciences, Chiba, Japan). Bull. Chem. Soc. Japan, 35: 1811-13(Nov. 1962). (In English)

C^{14} measurements are reported for thymol in an essential oil from plants harvested in the pre-war years and from 1954 to 1961. The quenching effect of thymol in liquid scintillation counting was masked by methylation of the phenolic hydroxy group. The measured C^{14} contents increased 18.4% from 1954 to 1961, from 14.05 to 17.49 dpm/g carbon. (D.L.C.)

15619 RADIATION FALLOUT AND ITS HEALTH IMPLICATIONS. R. D. Connor (Univ. of Manitoba, Winnipeg, Can.). Can. J. Public Health, 52: 333-7(Aug. 1961).

At the University of Manitoba day-to-day variations of radioactivity in the air were recorded for over 1 year. It was found that heavy rain or snow greatly reduces the natural atmospheric radioactivities but affects the weapons test fallout concentration only slightly. The estimated orders of magnitude from fallout were: radon 100, thoron 1, and fallout 1 $\mu\mu c/m^3$. Observations in Winnipeg showed that in December 1958 the amount of fallout in air was rising due to the increased rate of deposition from the Russian and American tests in 1958. Thereafter the activity reached a flat maximum and in June 1959 a decrease was noted, which continued until the end of August at an increasing rate. Later observations (December 1960) showed that the fallout in air corresponded to about 0.5 $\mu\mu c/m^3$ which is $\frac{1}{8}$ the mean value for the beginning of 1959. Thus the amount of artificial activity in the air decreased considerably during 1959 and without further testing can be expected to fall even more. The public health aspects of fallout radionuclides, especially Sr^{90} and Cs^{137}, are discussed in relation to their observed concentrations in the biosphere. Apart from a pronounced increase in the middle of 1959 due to the nuclear explosions in 1958, the Sr^{90} content of Winnipeg milk showed a significant fall between the spring of 1958 and the fall of 1960. Figures for the national average closely parallel those of Winnipeg. It is suggested that the principal factor affecting Sr^{90} concentration in milk may not be the total accumulation on the ground but rather the fallout of the preceding 2 months. Hence, the total accumulation is irrelevant and the bulk of the activity is not in but on vegetation. Comparisons were made of the relative doses to the populations of Great Britain and Canada from Sr^{90} as well as Cs^{137} and of their possible leukemogenic actions. (P.C.H.)

15620 ANTS (FORMICA RUFA) AS POSSIBLE INDICATORS FOR RADIOACTIVE FALLOUT. Rémy Chauvin, Guy Courtois, and François Anguenot (C. E. A., Saclay, France). Compt. rend. 256: 508-11(Jan. 7, 1963). (In French)

A measurement of the radioactivity of anthills was made, and the results lead to the conclusion that the radioactivity is found in the ants and not in the anthills themselves. An examination of the gamma spectrum shows an apparent period of 38 days. It is suggested that the ants fix the fallout by a mechanism in direct connection with their habit of sampling the sugar excretion of tree aphis. The importance of ants as fallout detectors cannot be evaluated as yet. (J.S.R.)

15621 CONTRIBUTION TO THE CLARIFICATION OF REASONS FOR THE ENRICHMENT OF Cs-137 IN ORGANISMS. W. Forth, E. Oberhausen, K. Pfleger, and G. Weske (Universität, Saarlandes, Homburg, Ger.). Experientia, 19: 25-6(Jan. 15, 1963). (In German)

In rabbit erythrocytes, the rate constant of the influx of potassium was 4.5 times higher than that of cesium ions. The efflux of potassium was 1.5 times higher. The cesium transport into the cells was completely inhibited by 1.36×10^{-5} m ouabain, a concentration which also blocks the potassium transport. It was calculated that cesium accumu-

lates 3 times less than potassium within the red blood cells. (auth)

15622 ON THE ACCUMULATION OF P^{32} BY VARIOUS WATER BODIES. D. Z. Gak (Inst. of Hydrobiology, Kiev). Radiobiologiya, 2: 938-43(1962). (In Russian)

Uptake of P^{32} by phytoplankton, bacterioplankton, zooplankton, water thyme, overgrowth, and sand was 128 μC/l in the initial stage of a 46-day experiment. Radioactivity of the phyto- and bacterioplankton was proportional to their biomasses. Sand accumulation was identical to that of the solution, while in zooplankton, water thyme, and overgrowth the concentration exceeded the solution concentration by a factor of 4, and the bacterio- and phytoplankton concentration by a factor of 5. The accumulation dynamics for P^{32} in zoo- and bacterioplanktons indicates a direct digestive relation between these organisms. The maximum uptake of P^{32} by sand and water thyme takes place at the first introduction; in bacteria and animal plankton, 3 hours later. (R.V.J.)

15623 ACCUMULATION OF Sr, Ca, Ce, AND Y RADIOISOTOPES BY CRUSTACEA. N. N. Khmeleva (Inst. of Zoology, Leningrad). Radiobiologiya, 2: 944-6(1962). (In Russian)

Studies of Sr^{90}, Ca^{45}, Ce^{144}, and Y^{91} uptake by Gammarus lacustris indicated strong ability of crustacea for accumulating radioisotopes, especially cerium (on the 16th day the accumulation coefficients were 528 to 1150). Additions of EDTA considerably reduced (by a factor of 33 to 126) the uptake of calcium, cerium, and yttrium, and increased the uptake of strontium by a factor of 4. (R.V.J.)

15624 UMWELTRADIOAKTIVITÄT UND STRAHLENBELASTUNG. BERICHT I/62. (Environmental Radioactivity and Radiation Burden. Report I/62). Bad Godesberg, Ger., Bundesminister für Atomkernenergie, 1962. 110p.

A report is presented on the content of radioactive materials in air, water, soil, and food and the radiation burden to the population of the Federal Republic of Germany for the first quarter of 1962. The results of monitoring radiation in the air and environment, fallout and precipitation, surface water and waste water, drinking water, soil, and nutrition chains are given. The measurements of the contents of Sr^{90} and Cs^{137} in humans are reported. All results are presented in tabular form. (M.C.G.)

15625 UMWELTRADIOAKTIVITÄT UND STRAHLENBELASTUNG. BERICHT II/62. (Environmental Radioactivity and Radiation Burden. Report II/62). Bad Godesberg, Ger., Bundesminister für Atomkernenergie, 1962. 126p.

A report is presented on the content of radioactive materials in air, water, soil, and food and the radiation burden to the population of the Federal Republic of Germany for the second quarter of 1962. The results of monitoring radiation in the air and environment, fallout and precipitation, drinking water, sea water, soil, and food chain are presented in tabular form. (M.C.G.)

Radiation Effects on Living Tissues

15626 (BNL-6027) STUDIES ON EFFECTS OF RADIATION ON MAIZE. Dale M. Steffensen (Illinois. Univ., Urbana and Brookhaven National Lab., Upton, N. Y.). [nd]. Contract [AT-30-2-GEN-16]. 5p.

Maize plants were exposed to approximately 750 r γ radiation at various times after pollination in order to produce chimeras in embryos. Embryos heterozygous for factors on chromosome 9 from a number of crosses were irradiated at various periods after pollination. Kernels resulting from this treatment were grown and the number of albino and blue fluorescent seedlings were observed. Data are summarized from observations on cytoplasmic inheritance in the mutants. (C.H.)

15627 (CRB-1129) RADIATION BIOLOGY IN CANADA 1962–63. D. G. Thacker (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1963. 60p. (AECL-1701)

A survey is presented of the research projects in radiation biology being carried out in Canada during the fiscal year 1962–63. The names of the investigators, their location, a brief description of the projects, and information on the financial support being provided are included. A classification of the projects into areas of specific interest is also included. (auth)

15628 (EIR-41) ESTIMATION OF DOSE FROM A SINGLE INTAKE OF RADIOACTIVE MATERIAL. F. Adler (Switzerland. Eidgenössisches Institut für Reaktorforschung, Würenlingen). Nov. 1962. 11p.

A method is described for estimating the radiation dose from a single intake of radioactive material based on the corresponding maximum permissible concentration value. Results are included, calculated in water and in air, for 12 radioisotopes and several unidentified mixtures. (C.H.)

15629 (LADC-5278) BREEDING CHARACTERISTICS OF OFFSPRING FROM TEN GENERATIONS OF X-IRRADIATED SIRES. J. F. Spalding, V. G. Strang, and W. L. LeStourgeon (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 15p.

The reproductive efficiency of mice, as measured by litter data and breeding characteristics, of offspring of 10 generations of x irradiated sires was observed. The performance of control line mice was superior to that of irradiated line mice for 18 of 22 breeding characteristics. The inheritance of several radiation-induced deleterious recessive mutants and of a lethal sex-linked or a sex-limited mutation was indicated. (auth)

15630 (LADC-5401) THE EFFECT OF ANCESTRAL IRRADIATION EXPOSURE ON RADIORESISTANCE IN THEIR DESCENDANTS. J. F. Spalding, V. G. Strang, and W. L. LeStourgeon (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 24p.

The comparative resistance of 3 lines of mice with different histories of ancestral x-ray exposure to protracted γ irradiation, fractionated x irradiation, and acute LD_{50}^{30} x irradiation was studied. Mice from 15 generations of x-irradiated sires and 10 generations of x-irradiated sires, followed by 6 generations with no irradiation, were comparatively less resistant to both protracted γ ray and fractionated x ray exposure than were control line mice. There was no comparative LD_{50}^{30} difference among the 3 groups. (auth)

15631 (NP-12601) EFFECT OF HIGH LEVELS OF IONIZING RADIATION ON ANIMAL TISSUES. Contract Research Terminal Report. Kenneth J. Monty (Johns Hopkins Univ., Baltimore. McCollum-Pratt Inst.). Sept. 30, 1962. Contract DA-49-007-MD-631. 51p.

Two general classes of carbonyl compounds were formed in animal tissues exposed to doses of ionizing radiations required for radiation processing. The group of water-soluble carbonyl compounds consisted largely of keto-acids derived from the oxidative deamination of amino acids. The group of diphatic carbonyl compounds was apparently derived from the radioinduced degradation of various lipid molecules. Analytical methods for the determination of lipid-derived carbonyl compounds are described. The toxicity of the carbonyl compounds was investigated in rats. It was concluded that the formation of carbonyl com-

pounds during the radiation processing of meats does not affect the nutritive value or the wholesomeness of the meat. (C.H.)

15632 (ORO-584) HISTOCHEMICAL STUDIES ON THE EFFECTS OF IONIZING RADIATION ON INTESTINAL EPITHELIUM. (Texas. Univ., Austin). [1962]. Contract AT(40-1)-2890. 7p.

Progress is reported in histochemical studies on the effects of low-level radiation on enzymatic activity in intestinal epithelium and changes in intestinal epithelium during normal aging and after radiation exposure. (C.H.)

15633 (SAM-TDR-62-103) PROTECTION AGAINST IONIZING RADIATION. X-IRRADIATED MONKEYS RECEIVING PREIRRADIATION PROPHYLAXIS AND POST-IRRADIATION THERAPY. George S. Melville, Jr., George W. Harrison, Jr., Thomas P. Leffingwell, Walter H. Whitcomb, and Robert J. Young (Texas. Univ., Austin. Radiobiological Lab.). Dec. 1962. 10p. (AD-296556)

Issued by School of Aerospace Medicine, Brooks AFB, Tex.

Postirradiation symptomatic therapy of the radiation syndrome was utilized to provide significant extension of survival time, compared to irradiated controls, of Macaca mulatta primates x irradiated to a total dose of 900 r. The therapeutic regimen was successfully combined with chemical radioprotectants to enhance survival time in a third group of animals. This combined treatment was more effective than the therapy alone. The overall clinical condition of these animals was far superior to that of the untreated irradiated animals. Pathologic studies of the deceased animals indicate that the two major causes of death were bone marrow failure and severe lymphoid atrophy. The protective chemical treatment is in itself a combination of different mechanisms of radioprotection, routes of administration, and sites and rates of absorption of the drugs. (auth)

15634 (TID-15964) FUTURE PROGRESS IN STUDIES OF THE EFFECTS OF RADIATION ON MAN. Karl Z. Morgan (Oak Ridge National Lab., Tenn.). [1961]. Contract [W-7405-Eng-26]. 36p.

The effects of ionizing radiation on man are discussed. Data are reviewed from all available records of human exposures. It is pointed out that such data are of inestimable value in setting an acceptable level of body burden for both internal and external radiation exposure and in establishing values for maximum permissible concentration of radionuclides in air, water, and food. Results are summarized from hundreds of animal experiments conducted to determine the types of radiation damage and to acquire metabolic information associated with internal exposure to available radioisotopes. The data show that medical exposure to the average man in the U. S. is in excess of all other sources of exposure combined and that during 1960 the average radiation dose from fallout was less than 2% of the medical dose. (C.H.)

15635 (TID-17762) RADIONUCLIDES AND IONIZING RADIATION IN ORNITHOLOGY: A SELECTED BIBLIOGRAPHY ON WILD AND DOMESTIC BIRDS. Vincent Schultz (Division of Biology and Medicine. Environmental Sciences Branch, AEC). Feb. 1963. 29p.

Three-hundred-twenty-eight references are presented on the effects of fallout from nuclear tests on wild bird populations and the accumulation of radionuclides by wild and domestic birds. (C.H.)

15636 (TID-18061) THE EFFECT OF X-RAY IRRADIATION ON THE DESOXYRIBONUCLEIC ACIDS OF THE SPLEEN AND RADIOSENSITIVE TISSUE. Progress Report, May 1, 1962–January 31, 1963. Henry P. Schwarz (Philadelphia General Hospital). Contract AT(30-1)-2568. 25p.

Spleen DNA from whole-body irradiated rats and controls was studied with anion exchange chromatography, infrared spectroscopy, and electrometric titration. These studies showed that ionizing irradiation at 1000 to 3000 r caused an increase of a low molecular DNA fraction eluted from ECTEOLA-cellulose at neutral pH to up to two times of the control value. Infrared spectroscopy similarly indicated such an increase of low molecular DNA by showing a definite decrease of the extinction coefficients of the band at 970 cm^{-1} (10.3 u), which is caused by the internucleotide (P–O–C_5') linkages in the irradiated DNA. Preliminary results of electrometric titrations indicate some breaks of hydrogen bonds in irradiated DNA and are possibly suggestive of separation of the helixes following the exposure to x rays. (auth)

15637 (TID-18135) THE OCCURRENCE OF CHROMOSOMAL ABERRATIONS IN PRE-SPERMATOCYTIC CELLS OF IRRADIATED MALE MICE. Progress Report, February 1, 1962–January 31, 1963. Allen B. Griffen (Roscoe B. Jackson Memorial Lab., Bar Harbor, Me.). Feb. 1, 1963. Contract AT(30-1)-2113. 19p.

An investigation was made of the nature and extent of radiation injuries to the chromosome system of pre-spermatocytic cells, including spermatogonia and their precursors, in male mice exposed to three dose levels of x radiation. The treated males were mated to unexposed females and offspring sired by each male throughout the remainder of his life were tested for the presence of chromosomal aberrations capable of producing semi-sterility. All semi-sterile lines and all sterile F_1 males were analyzed cytologically. Following irradiation of the testes an initial period of good fertility was observed for about one month, followed by a period of sterility that varied with the radiation dose, and a period of renewed fertility that continued throughout the remainder of the lifespan. Spermatogenesis ceased and spermatogonia were scarce or absent during the sterile period. (C.H.)

15638 (TID-18139) EFFECTS OF RADIATION ON THE DEVELOPING NERVOUS SYSTEM. Samuel P. Hicks (Michigan. Univ., Ann Arbor). Revised and new material added Jan. 1963. Contract AT(11-1)-1201. 24p.

The effects of ionizing radiations on the development of the nervous system are reviewed. It is pointed out that most of the information about the deleterious effects of radiation in early development of embryos and fetuses is based on animal experiments. Exposure of human embryos and fetuses to therapeutic radiation while their mothers are being treated for tumors in the pelvis has led to results ranging from death of the fetus to viable malformed offspring. General underdevelopment of the body, often with reduced head size, and mental retardation have been reported. No information is available on the effects of small doses of radiation on developing man. Data from laboratory studies in rats are summarized. Topics discussed include the direct effects of radiation during early development of the nervous system, mechanisms of malformation and radiosensitivity, behavioral studies in animals irradiated during development, indirect effects of radiation during development that may affect nervous system function, the effects of low radiation doses, and the induction of somatic mutations. (C.H.)

15639 (TID-18194) A STUDY OF THE EFFECTS OF X-IRRADIATION OF EXCLUSIVELY THE CIRCULATING BLOOD ON THE ANTIBODY PRODUCING MECHANISM OF

THE RABBIT. Final Report, October 1, 1959–September 30, 1962. Peter Abramoff (Marquette Univ., Milwaukee). Contract AT(11-1)-820. 78p.

The effects of irradiation of exteriorized circulating blood on the formed elements and serum proteins were studied in rabbits. The indirect effects of extracorporeal irradiation on the histological picture of the spleen and lymph nodes as correlated with precipitin production were analyzed in rabbits. The technique used for irradiating the circulating blood and methods used for quantifying the absorbed dosage under these experimental conditions are described. (C.H.)

15640 (TID-18203) ULTRAVIOLET-INDUCED APOCHLOROSIS AND PHOTOREACTIVATION IN TWO STRAINS OF EUGLENA GRACILIS. J. R. Cook (California. Univ., Los Angeles. School of Medicine. Lab. of Nuclear Medicine and Radiation Biology). [Mar. 11, 1963]. Contract AT(04-1)-Gen-12. 10p.

Ultraviolet-induced apochlorosis and photoreactivation were investigated in two strains of Euglena gracilis, var. bacillaris and strain Z cultured at three different temperatures prior to irradiation. It was found that incubation temperature was without effect on the apparent sensitivity to ultraviolet light. A striking difference was observed in the degree to which the two cell types were reactivated by visible light. Reaction mechanisms involved are discussed. (C.H.)

15641 (TID-18221) RADIATION DAMAGE IN MUSCLE CELL MEMBRANES AND REGULATION OF CELL METABOLISM. Adolfo Portela, Juan Carlos Perez, Peter Stewart, Marion Hines, and Vasunder Reddy (Emory Univ., Atlanta). [196?]. Contract [AT(40-1)-2700]. 53p.

The absence of detectable early effects on frog striated muscle of low doses (under 10,000 r) of x rays has been reported. Effects of higher (100,000 r) doses include prolonged relaxation time, more rapid fatigue, and decreased ATP and glycogen content, but increased potassium and sodium effluxes, sodium influx, and oxygen consumption, compared with non-irradiated controls. Twitch latency and rise time are not changed. Magnesium-activated ATPase activity of homogenates or mitochondrial suspensions decreases immediately after irradiation, but increases with time more rapidly than in controls. The biochemical findings suggest uncoupling of oxidative phosphorylation, while the ion flux data suggest increased membrane permeability. An hypothesis is suggested that irradiation results in membrane damage, both in the sarcoplasma membrane, thereby increasing ion permeabilities, and in the mitochondrial structure, thereby interfering with oxidative phosphorylation and reducing ATP production. A decrease in membrane potential during irradiation to about 90% of its control value has already been reported. The observed increases in Na and K fluxes after irradiation explain these findings. At these radiation levels, our data do not require any hypothesis of early direct damage to the contractile mechanism per se. (auth)

15642 (TID-18268) THE BEHAVIOR OF CELL MEMBRANES DURING AND FOLLOWING RADIATION. EFFECTS OF X-IRRADIATION ON MUSCLE MEMBRANE. Final Progress Report, April 15, 1962–April 15, 1963. Adolfo Portela and Juan Carlos Perez (Emory Univ., Atlanta). Contract AT(40-1)-2700. 17p.

Data are summarized from a series of studies on the effects of x radiation on frog muscle membrane. It was concluded that some stages of metabolism in muscle cells are more vulnerable than others to attack by radiation. The vulnerable stages appear to be those that control the rates of metabolic reactions. The structural organization of the muscle cells and their organelles was shown to be an important associated factor in the control of reaction rates. Structure was also shown to be responsible for compartmentation and the control of contact between potential reactants. The effect of irradiation on membrane potential and permeability to Ca^{45}, Na, and K was also investigated, and data are summarized. (C.H.)

15643 (USNRDL-TR-596) ACCELERATED INDUCTION OF HEPATOMAS IN FAST NEUTRON IRRADIATED MICE INJECTED WITH CARBON TETRACHLORIDE. L. J. Cole and P. C. Nowell (Naval Radiological Defense Lab., San Francisco). Nov. 19, 1962. 19p. (AD-296242)

Young adult (C57L × A)F_1 hybrid mice received a single whole-body exposure to fission spectrum fast neutrons (165 to 306 rad). Subgroups of these mice then received a single subcutaneous injection of CCl_4, given either at 2, 12, 15, or 18 months post-irradiation. Control non-irradiated mice received a single injection of CCl_4. Other groups of mice were exposed to a single 500 rad dose of 250 KVP x rays. The incidence of hepatomas was markedly increased in the neutron-irradiated mice (19%) as compared with that in the x-irradiated mice (2%). In the neutron-irradiated mice injected with CCl_4, the hepatoma incidence attained a value of 61%, three times that in the mice irradiated with neutrons only. In addition, marked pleomorphism and atypicality of liver cell nuclei were evident in almost all of the neutron-CCl_4 mice, but were observed in only 6 of the 47 mice exposed to neutrons only. Of the small group of mice which received CCl_4 but no irradiation, and sacrificed up to 22 months later, none exhibited hepatomas or nuclear abnormalities. In this system therefore, CCl_4 seems to act as a promoting agent in liver carcinogenesis. These findings, taken together with other data in the literature, support the concept that hepatoma induction is accelerated as a consequence of the action of a specific proliferative stimulus on cells bearing a latent radiation-induced alteration. The general question of the role of proliferative stimuli in radiation carcinogenesis is discussed. (auth)

15644 (USNRDL-TR-605) MOUSE FETAL LIVER: A SOURCE OF IMMUNOLOGICALLY REACTIVE CELLS. M. L. Tyan and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Jan. 3, 1963. 17p. (AD-296581)

Male and female AHeJ mice were mated and the resulting pregnancies were surgically interrupted at various stages of gestation. The embryos were dissected and identical organs (liver, thymus, gut, placenta, and umbilicus) from each separate pregnancy were pooled and injected i.p. into sublethally irradiated (500 rad) F_1 hybrids (either ((BALB/c × A))F_1 or ((C57L × A))F_1). Death of the F_1 hybrids within 60 days was the criterion for the presence of immunologically competent cells in the inoculum. At the end of this period the survivors were sacrificed, their spleens and lymph nodes homogenized, and injected i.p. into sublethally irradiated F_1 hybrids of the other type. Again death within 60 days was the criterion for the presence of immunologically competent cells in the inoculum. One death occurred among the primary hosts. Immunologically competent cells were detected in secondary recipients of 2nd trimester fetal liver, 2nd trimester thymus, and 3rd trimester fetal liver. No immunologically competent cells were found in secondary recipients of 3rd trimester and newborn thymus. Deaths occurred among secondary hosts of fetal gut, umbilicus, and placenta. There were two deaths among the secondary control mice. It was concluded that 2nd and 3rd trimester mouse fetal liver, 2nd trimester

fetal thymus, and perhaps other fetal tissues contain potential immunologically competent cells. The theoretical significance of these data is discussed. (auth)

15645 (USNRDL-TR-608) SODIUM DEPENDENCE OF BIOELECTRIC OUTPUTS IN RAT STOMACH. J. T. Cummins and B. E. Vaughan (Naval Radiological Defense Lab., San Francisco). Jan. 14, 1963. 12p. (AD-297540)

When sodium in a Krebs-Ringer type media was replaced by choline, the potential difference across rat stomach as measured in vitro was substantially eliminated. Substitutions of sulfate for chloride and of sodium for potassium did not affect the bioelectric measurements. A residual potential of −2mV was detected, which was sensitive to anoxia and dependent neither on sodium nor on chloride. (auth)

15646 (USNRDL-TR-619) DIFFERENTIAL RADIOSENSITIVITY OF FIRST- AND SECOND-SET RESPONSES TO ALLOGENIC AND XENOGENIC SKIN GRAFTS IN LETHALLY IRRADIATED MICE. M. L. Tyan and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Feb. 5, 1963. 24p. (AD-298632)

Two consecutive BALB/c mouse or rat skin tail grafts were placed on 12 to 14 week old female LAF_1 mice. One week following the rejection of the second graft, the mice received 870 rad whole-body x radiation and an intravenous infusion of isogenic bone marrow. At various times following irradiation (0.2, 2.0, 13 and 30 days), groups of mice received orthotopic tail skin grafts from LAF_1, BALB/c and C3D/2 mice, and Sprague-Dawley rats. The experiments were appropriately controlled. The resulting data demonstrated the differential radiosensitivity of first- and second-set responses to either allogenic (H-2 difference) or xenogenic (rat) skin grafts: i.e., the second-set response of mice pre-sensitized with either allogenic or xenogenic skin grafts is more radioresistant than is the first-set response. The second-set response to a xenogenic skin graft is more radioresistant than is that to an allogenic graft. The converse appears to be true with regard to the first-set response. The theoretical implications of these findings are discussed. (auth)

15647 (JPRS-18020) THE SIGNIFICANCE OF PLASMA CELLS IN ANTIBODY FORMATION PROCESS DURING IONIZING RADIATION. L. G. Kovtunovich and A. Yu. Rubnitskaya. Translated from Arkh. Patol., 24: No. 12,, 15-21(1962). 11p. (OTS-63-21277)

The effects of whole-body irradiation on antibody formation were studied in rats given vaccine or antitoxin. A close correlation was noted between the serum antibody content and the number and degree of maturity of plasma cells in lymph nodes and spleen. (C.H.)

15648 STUDIES ON THE BIOLOGICAL EFFECTS OF 30 Mev ELECTRONS. Tadeusz Rudnicki. Acta Physiol. Polon., 13: 705-15(Nov.-Dec. 1962). (In Polish)

Quantitatively, mitotic processes induced in liver cells injured in the resting stage by a dose of 450 r are approximately the same irrespective of whether 30-Mev electrons or 180-kv x rays have been used. Injuries caused by fast electrons are slightly milder. Fast electrons have a selective effect in that they prolong the prophase. In their biological effects on normal liver cells in the resting stage, 30-Mev electrons are only slightly less efficient than 180-kv x rays. (auth)

15649 STUDIES ON INDUCED VARIATION IN THE RHIZOBIA. III. HOST RANGE MODIFICATION OF RHIZOBIUM TRIFOLII BY SPONTANEOUS AND RADIATION-INDUCED MUTATION. E. A. Schwinghamer (Brookhaven National Lab., Upton, N. Y.). Am. J. Botany, 49: 269-77 (Mar. 1962). (BNL-5606)

Mutant strains capable of nodulating pea seedlings ineffectively (incapable of nitrogen fixation) were obtained from 2 antibiotic-resistant marked strains of Rhizobium trifolii which normally do not form nodules on this host. Such variant forms apparently occur spontaneously in these strains at a low frequency which can be significantly increased by irradiation with ultraviolet light, x rays, and fast neutrons. Nodulation of vetch, sweet peas, and several varieties of peas by the mutant strains suggests a close parallelism of the extended host range with the range of R. leguminosarum, although nitrogen fixation by the mutants on the new hosts is negligible or absent. The mutant nodules on these hosts also differ from those of pea strains in slightly smaller size, spherical form, and lighter pink color. Nodule morphology on the homologous host, clover, appears unaltered but a slight loss of effectiveness was noted on red clover. This loss may be attributed partly to a reduction in infective ability since the average number of nodules formed per plant of clover or pea is appreciably lower than for comparable inoculation by strains of nonmutant R. trifolii or R. leguminosarum, respectively. Cultural characteristics of mutant strains resemble those of the nonmutant R. trifolii strains. (auth)

15650 CHANGES IN SENSITIVITY OF MAIZE CHROMOSOMES TO X RAYS DURING SEED GERMINATION. Richard L. Latterell and Dale M. Steffensen (Brookhaven National Lab., Upton, N. Y.). Am. J. Botany, 49: 472-8 (May-June 1962).

Changes in the radiosensitivity of maize seeds during early stages of germination were studied by means of somatic-mutation techniques. Seeds heterozygous for the yg_2 (yellow-green) locus were irradiated with 800 r of x rays after soaking in running tap water up to 42 hr. Yellow-green sectors, representing mutations affecting the dominant yg_2 locus, in leaves 4 and 5 of seedling plants were used as a criterion of radiosensitivity. The frequency of somatic sectors was virtually nil for dry seed and for seeds soaked up to 16 hr. Sector frequencies underwent a marked (9- to 15-fold) rise from 16 to 28 hr, reached a plateau of sensitivity and subsequently declined. Manometric studies were conducted on seeds soaked under the same conditions as those irradiated. The rate of oxygen consumption rose rapidly from 0 to 7 hr, remained essentially constant from 7 to 16 hr, then underwent an approximately 2-fold increase from 16 to 24 hr, after which the rate of progressive increase was retarded. The fact that the marked rise in frequency of x-ray-induced somatic sectors coincided with the major increase in oxygen consumption suggests that radiosensitivity of soaked seeds is conditioned by metabolic changes during seed development. Changes in radiosensitivity that followed attainment of peak sector frequencies were apparently governed by factors that influenced the rate of seed development. (auth)

15651 NONESSENTIALITY OF CONCURRENT CELL DIVISIONS FOR DEGREE OF POLARIZATION OF LEAF GROWTH. I. STUDIES WITH RADIATION-INDUCED MITOTIC INHIBITION. Alan H. Haber (Oak Ridge National Lab., Tenn.). Am. J. Botany, 49: 583-9(July 1962).

During germination and seedling growth, the first foliage leaf of wheat shows polarized growth with striking changes in shape. During this polarized growth, most of the new cell plates are formed perpendicular to the axis of greatest elongation (longitudinal axis). The relation between leaf length and leaf width is the same in leaves normally grow-

ing with cell division as in leaves growing with negligible cell division after gamma-irradiation (800 kr) of the unsown grain. Although cell division is necessary for continued growth and normal development, concurrent cell divisions play no role in determining the degree of polarization, i.e., the ratio of the rates of linear extension in length per mm length to linear extension in width per mm width. The majority of the new cell plates formed before the growth period studied was parallel to the axis of greatest absolute and relative elongation during the growth period studied. Irradiated and unirradiated wheat having the same leaf size, and thus the same leaf shape, have quite different cell sizes, shapes, and numbers in both the leaf epidermis and the chlorenchymatous mesophyll. It is concluded that the orientations of cell divisions, whether concurrent with or prior to the growth period studied, play no role in the basic mechanism which determines the manner in which leaves change shape; and genetic information specifies leaves form independently of genetic influences on sizes and shapes of cells and on the extents and orientations of cell divisions. (auth)

15652 INTERACTION OF IONIZING AND VISIBLE RADIATION IN MUTATION INDUCTION IN NEUROSPORA CRASSA. Richard M. Klein and Deana T. Klein (New York Botanical Garden, New York and Albert Einstein Coll. of Medicine, New York). Am. J. Botany, 49: 870-4(Sept. 1962).

Conidia of the purple adenineless strain of N. crassa were irradiated with 25 kr of x rays and then exposed to far-red or red radiations or to far-red followed by red radiation. Far-red light, without effect on unirradiated conidia, augmented the genetic damage caused by x rays as measured by survival (colony count), back mutation to adenine prototrophy, and the induction of mutants affecting colony morphology. Post-x-irradiation with red light ameliorated the severity of x radiation as measured by survival and back mutation. The potentiation of x-ray-induced genetic damage by far-red light could be completely negated by subsequent exposure to red light. (auth)

15653 THE EFFECTS OF TRITIATED THYMIDINE INCORPORATION ON SECONDARY ROOT PRODUCTION BY PISUM SATIVUM. Margaret R. Hummon (Montana State Univ., Missoula). Am. J. Botany, 49: 1038-46(Nov.-Dec. 1962).

Tritiated thymidine offers a tool for selective irradiation of the nucleus with little effect on the cytoplasm of a cell. Differential incorporation due to variation in the pattern of DNA synthesis permits selective irradiation of cells and tissues. Developing primary roots of Pisum sativum were submerged for brief periods in a solution of tritiated thymidine. This resulted in an alteration of the lateral root pattern. In the area corresponding to the region of elongation during treatment, subsequent lateral root production was suppressed. This correlated with the portion of the root in which there was incorporation of tritiated thymidine into a high percentage of pericycle nuclei. Abnormal development of vascular tissues also occurred, with evidence of altered polarity in the xylem. Although incorporation also occurred in the apical meristem, the latter was not affected at this level of exposure. Thus, differential sensitivity as well as differential incorporation may have been involved in producing the temporary alteration of lateral root production. (auth)

15654 A HISTOPATHOLOGIC STUDY IN MICE IMMUNIZED AGAINST TRICHINELLA SPIRALIS AND EXPOSED TO TOTAL-BODY X IRRADIATION. John E. Larsh, Jr., George J. Race, and Allen Yarinsky (Univ. of North Carolina, Chapel Hill). Am. J. Trop. Med. Hyg., 11: 633-40 (Sept. 1962).

Immunized and nonimmunized mice were irradiated with 450 r and challenged with 200 T. spiralis larvae. The larvae used for the immunizing (but not the challenging) injections had been sterilized by x irradiation (3500 r). Histopathologic changes in small intestine were studied at various intervals postchallenge. Nonirradiated, immunized mice showed a subacute inflammatory response similar to that in untreated mice at 7 days postchallenge. However, the irradiated, immunized mice showed a response that differed in type and degree. In those irradiated 12 days prior to challenge (19 days prior to necropsy), there was a striking subacute response, which was similar, except in intensity, to that noted in the nonirradiated, immunized mice. Extensive lymphoid proliferation in the irradiated mice suggested recovery was underway. The findings were consistent with adult-worm counts for comparable groups in classifying the immune status. By both measurements, those irradiated 8 days prior to the challenge had no demonstrable acquired immunity, while those irradiated 12 days prior to challenge had immunity of an intermediate degree. On the basis of these and other observations an hypothesis is presented to explain the irradiation interference with previously established immunity. (P.C.H.)

15655 THE BEHAVIOR OF 100 DAY OLD MALE RATS RESULTING FROM FETAL X-IRRADIATION. S. J. Kaplan, R. Rugh, and R. K. White (Texas Technological Coll., Lubbock, and Columbia Univ., New York). Atompraxis, 9: 11-16(Jan. 1963). (In English)

Eighty-four male 100-day-old rats were studied for maze learning efficiency following exposure to various doses of x rays on various gestation days. In one experiment it was shown that 50 r delivered on gestation days 4.5, 6.5, 7.5, 8.5, 9.5, and 12.5 produced significant differences in learning ability. On the other hand, in a second experiment it was demonstrated that rats given as much as 150 r on the 8.5 gestation day showed no significant differences in learning ability. It was concluded that, in terms of functional impairment following radiation, there is a curvilinear relationship between sensitivity to damage and chronological development. It is postulated that damage occurs increasingly during the first seven days in utero, diminishes on the eighth and ninth days and increases again from the twelfth day through birth. It is emphasized that "damage" implies damage of tissues essential to the specific act of learning the particular maze under study. (auth)

15656 ADAPTIVE REGULATION OF ASCORBIC ACID SYNTHESIS IN RAT-LIVER EXTRACTS. EFFECT OF X-IRRADIATION AND OF DIETARY CHANGES. F. Stirpe and M. Comporti, and G. Caprino (Universita, Siena, Italy). Biochem. J., 86: 232-6(Feb. 1963).

The synthesis of ascorbic acid by rat-liver extracts is impaired after whole-body x irradiation of the animals. This impairment is caused by the reduction of food intake after irradiation. The synthesis of ascorbic acid is greatly reduced after starvation for 24 hr. Administration of glucuronolactone has little effect on the synthesis. Feeding rats with a carbohydrate-free diet for 24 hr causes a considerable reduction of ascorbic acid synthesis. A less severe reduction is observed if this diet is given for 6 days. It is concluded that the enzymes synthesizing ascorbic acid are adaptive to dietary carbohydrates rather than to the direct substrate. (auth)

15657 THE DOSE-TIME RELATIONSHIP IN RADIOTHERAPY. F. Ellis (Churchill Hospital, Oxford). Brit. J. Radiol., 36: 153-62(Mar. 1963).

The use of fractionated doses in clinical radiotherapy is discussed, and the literature reviewed. An attempt is made to interpret some of the well-known facts in terms of cellular radiobiology. Assuming cell survival curves to apply to organized tissues, and assuming values for the mitotic cycle times of normal and tumor cells, the efficiency of common treatment plans involving fractionated doses are compared. (auth)

15658 DOSE-TIME RELATIONSHIPS IN RADIOTHERAPY AND THE VALIDITY OF CELL SURVIVAL CURVE MODELS. J. R. Fowler (Hammersmith Hospital, London) and Babette E. Stern. Brit. J. Radiol., 36: 163-73(Mar. 1963).

The increase of dose with overall time in radiotherapy could be due either to slow tissue repair, or to the relatively smaller effectiveness of smaller individual fractions, or to both. From experimental results with pig skin, and on general grounds which are discussed, the second explanation appears to be the important factor. The extent to which experimental mammalian cell survival curves can explain the observed clinical dose-time relationships was investigated. It is concluded that such a simple theoretical model could explain the observed clinical data only if curves with extrapolation numbers of about 10 or with shapes that continue to show downward curvature with increasing dose are appropriate. (auth)

15659 CLINICAL ASPECTS OF FRACTIONATION AND DOSE-TIME RELATIONSHIPS. D. K. Sambrook (Swansea Hospital, Eng.). Brit. J. Radiol., 36: 174-7(Mar. 1963).

Recent research in radiobiology indicates that many different kinds of mammalian cell, both normal and malignant, show similar radiosensitivity with respect to loss of reproductive integrity, if at the same oxygen tension. The shoulder at the beginning of the dose-response curve implies that fractionation must reduce the efficiency of irradiation, and with a relatively greater loss of effect on hypoxic cells, probably present in many tumors. Nevertheless, clinical experience with extended fractionation methods confirms their value. It is suggested that this is due to differences in the cell-population kinetics of normal and malignant tissue. Such differences can be even further exploited by split-course methods, making possible high tumor doses with reduced normal tissue damage. (auth)

15660 THEORETICAL IMPLICATIONS OF CELL SURVIVAL DATA IN RELATION TO FRACTIONATED RADIOTHERAPY TREATMENTS. R. Oliver (Churchill Hospital, Oxford). Brit. J. Radiol., 36: 178-82(Mar. 1963).

Similar dose response curves in respect of reproductive integrity have been demonstrated for a variet of cell types in vitro and in vivo. These show an init al ineffective shoulder, corresponding to a buildup of non-lethal damage at low doses, which, it has been shown, is recoverable in a period of some ten hours. Assuming this type of dose-response curve to apply in connection with radiotherapy, there are theoretical implications relating to dose fractionation. (auth)

15661 SOME COMPARISONS OF FRACTIONATION EFFECTS BY ERYTHEMA MEASUREMENTS ON HUMAN SKIN. A. H. W. Nias (Churchill Hospital, Oxford). Brit. J. Radiol., 36: 183-7(Mar. 1963).

A method is described for obtaining quantitative radiobiological data from human skin erythema measurements by the use of controlled comparisons. The fractionation factor of four daily fractions was found to be less than 120 per cent with respect to skin erythema. (auth)

15662 EXPERIMENTS WITH FRACTIONATED X-RAY TREATMENT OF THE SKIN OF PIGS. I. FRACTIONATION UP TO 28 DAYS. J. F. Fowler, R. L. Morgan, J. A. Silvester, D. K. Bewley, and B. A. Turner (Hammersmith Hospital, London). Brit. J. Radiol., 36: 188-96(Mar. 1963).

Experiments were carried out to compare the skin reactions in pigs produced by various regimes of fractionated irradiation with x rays, extending up to 28 days. A total of 27 x-ray fields were applied to two pigs. The results show that the major factor which determines the skin response is the size, or number, of the fractions, i.e., the shape of the dose-effect curve. This factor is found to explain approximately five-sixths of the increase of total dose required to produce a given reaction when the dose is divided into five fractions. The remaining one-sixth of the increase is due to tissue repair or repopulation occurring between five and 28 days. The implication in radiotherapy is as follows. If fractionated treatments using fewer and larger fractions are given over the same overall time as a daily regime, it is suggested that care must be taken to reduce the total dose below that used in the daily regime, in order to avoid greater skin damage. (auth)

15663 THE USE OF HEAVY METAL SHIELDING INCORPORATED IN STEPPED COMPENSATORS FOR ^{60}Co THERAPY. E. J. Hall and R. Oliver (Churchill Hospital, Oxford). Brit. J. Radiol., 36: 225-6(Mar. 1963).

The use of Al and W blocks as shielding incorporated in stepped compensators for Co^{60} γ therapy is described. The metal compensators correct for irregularities in the body surface so that standard isodose data may be applied in treatment planning. (C.H.)

15664 RADIOSENSITIVITY OF TUMOURS AND TARGET THEORY. Lionel Cohen (Johannesburg General Hospital). Brit. J. Radiol., 36: 226-7(Mar. 1963).

The target theory of radiation lethality in biological systems is discussed in terms of the radiosensitivity of tumors. The effect of variation in radiosensitivity among individual cells is considered. Typical semilog presentations are included of cellular lethality curves showing exponential, multihit, and multitarget types of radiation response. A composite curve with a specific level of immunological cut-off is discussed. Factors affecting radiosensitivity of tumor cells during clinical radiation therapy are considered. (C.H.)

15665 RELATIVE IMPORTANCE OF LATE SEQUELAE OF IRRADIATION IN MAN. R. R. Newell (Stanford Univ., San Francisco). Bull. N. Y. Acad. Med., 37: 383-410(June 1961).

An attempt was made to evaluate the relation of radiation exposure and dosage to the development of genetic mutations and somatic anomalies in man. However, it is not possible to validate a theory of genetic injury from observations on children and grandchildren of a few irradiated women. It is suggested that the extrapolation of results in mice to predictions in men should be based on a quantitative understanding of all the physiological systems, their equilibria and controls, and the effect of radiation on each, together with an adequate theory of homeostasis. An analysis of the human data on the leukemogenic action of radiation indicates that the dose-response relation is best expressed by a curvilinear (quadratic) regression rather than linear regression. The regression coefficient is as follows, assuming no threshold: leukemia produced per million man years = 1.59 (Mgrad). The hazards of Sr^{90}, Ra, and other bone-localizing radionuclides are also discussed, as well as possible dangers of, and precautions against overexposure from, medical diagnostic x rays. (P.C.H.)

15666 EXPERIMENTAL FINDINGS ON THE SIMILARITY OF THE VAGINAL AND BUCCAL RESPONSES TO RADIATION UNDER THE INFLUENCE OF TESTOSTERONE. L. Darcis (Université, Liege). Bull. Soc. Roy. Belge Gynecol. Obstet., 31: 573-80(1961).

Attempts were made to determine whether the radiosensitizing action of testosterone could be detected in locally irradiated rabbit tissue other than the vaginal mucosa. The jaw of rabbits was locally irradiated with 1000, 1500, 2000, 2500, and 3000 r doses of 50-kv x rays, given in a circular area of 2.5 cm dia), and smears of buccal cells were examined cytologically over the following 8 days. The surface area of buccal cells increased after irradiation, to a maximum on the 4th to 6th day, and the increase was proportional to the dose. Compared with a control area of 1.2, the maximum areas reached after the 5 respective x-ray doses were: 1.8, 2.3, 2.9, 4.1, and 4.8 (as 0.25×10^{-6} cm^2). Daily treatment of the rabbits with 10 mg testosterone propionate for 10 days, which did not significantly affect the control cell surface area, markedly increased the size of irradiated buccal cells. Thus, a 1000 r dose after testosterone treatment increased cell size to a degree produced by 2000-r irradiation alone. It was concluded that testosterone markedly sensitizes oral mucosa to x rays. (H.H.D.)

15667 THE DEMONSTRATION OF MORPHOLOGICAL NUCLEAR CHANGES IN PYKNOTIC IRRADIATED THYMOCYTES. J. F. Scaife (Dept. of National Defence, Ottawa). Can. J. Biochem. Physiol., 41: 823-5(Mar. 1963).

Pyknotic cells were evident in preparations of irradiated thymocytes examined with the electron microscope. It was concluded that pyknosis is thus a true morphological condition induced by irradiation. (C.H.)

15668 FACTORS INFLUENCING INACTIVATION OF INFECTIVITY AND HEMAGGLUTININ OF INFLUENZA VIRUS BY GAMMA RADIATION. John R. Polley (Dept. of National Health and Welfare, Ottawa). Can. J. Microbiol., 7: 535-41(Aug. 1961).

The effects of various conditions on the production of vaccines from PR8 influenza A virus by irradiation in a Co^{60} cell (at a rate of 1.25 Mrad/hr) are described. In purified virus suspensions in physiological saline, the hemagglutinin was destroyed more rapidly than infectivity. However, the addition of certain reagents reversed this effect. The most effective compounds for protection of the hemagglutinin during gamma irradiation are the sulfur-containing amino acids (cystine, cysteine, and methionine) and compounds containing a ring structure such as histidine, tryptophan, tyrosine, phenylalanine, sodium p-aminohippurate (PAH), and sulfanilamide. Ascorbic acid, an antioxidant, also exerts a protective action. The effect of a given amount of gamma radiation on infectivity and hemagglutinin was similar regardless of whether the radiation was administered as a single dose or as 2 to 4 divided doses on different days. Experiments were repeated with other strains of influenza A and B with similar results. Since the protective reagents added to virus suspensions were not of greatly different molecular weight, it appears that their protective effect on the hemagglutinin during irradiation is more likely due to an interference with chemical action. This suggests that the formation of a strongly oxidizing medium during irradiation accounts for much of the destruction of both the hemagglutinin and the infectivity. With these agents it is therefore possible by means of gamma radiation to destroy the infectivity of an influenza virus suspension while retaining most of the antigenicity. (P.C.H.)

15669 CLINICAL METHOD OF TESTING RADIATION-SENSITIZING AGENTS IN SQUAMOUS CELL CARCINOMA. Gilbert H. Fletcher, Herman D. Suit, Clifton D. Howe, Melvin Samuels, Richard H. Jesse, Jr., and Rene U. Villareal (Univ. of Texas, Houston). Cancer, 16: 355-63 (Mar. 1963).

Squamous cell carcinomas of the oral cavity and oropharynx provide suitable material for the evaluation of combined chemotherapy and radiotherapy because the therapeutic results in the primary lesions and in the metastatic lesions to the neck nodes can be assayed by palpation and inspection. From 1948 through 1960, approximately 400 cases of squamous cell carcinoma of the oropharynx, 500 of the oral cavity, and 250 of the supraglottic region of the larynx and of the piriform sinus and lateral hypopharynx were treated by a flexible program that included surgical resection, radiotherapy with x rays and Co^{60} γ rays, preoperative irradiation, and the use of radiation-sensitizing agents. Data on the treatment and outcome are tabulated. Results are presented from a clinical study on selected cases of the potentiation of radiation effects by 5-fluorouracil or 5-bromodeoxyuridine. It is pointed out that these chemical agents have different mechanisms of action and different modes of administration were used for each. Experimental procedures are described and results are discussed. (C.H.)

15670 MOLECULAR RADIOBIOLOGY OF HUMAN CELL LINES. III. RADIATION-SENSITIZING PROPERTIES OF 5-IODODEOXYURIDINE. R. L. Erikson and W. Szybalski (Univ. of Wisconsin, Madison). Cancer Res., 23: 122-30(Jan. 1963).

The radiosensitizing effects of 5-iododeoxyuridine (IUdR) incorporation into the DNA of human cells were systematically evaluated. The mode and degree of IUdR labeling were determined by analytical equilibrium-density-gradient ultracentrifugation. X-ray sensitization was found to depend on the total degree of thymidine replacement by IUdR and not on its distribution between the DNA strands. The factor of x-ray sensitization varied from 1.2 to 3.2 for cells grown at 10^{-7} to 5×10^{-5} M IUdR, respectively. Still higher x-ray sensitization ($3.7 \times$ at 2×10^{-5} M IUdR) was obtained under conditions of thymidylic acid synthesis inhibition (in the presence of 10^{-7} M 5-fluorodeoxyuridine), although cell viability was affected by IUdR in concentrations above 10^{-5} M. Equilibrium-density-gradient patterns revealed that the mode of DNA replication in D98/AG cells is of the semi-conservative type and that DNA can undergo more than one round of duplication even at the highest levels of IUdR labeling. (auth)

15671 MODIFICATION OF THE RADIOSENSITIVITY OF A TUMOR PREDECESSOR AFTER IRRADIATION. Edmond Malaise, Maurice Tubiana, and Georges Barski. Compt. Rend, 256: 519-22(Jan. 7, 1963). (In French)

The radiosensitivity of an experimental tumor of the mouse can be evaluated by the action of radiations on the speed of growth. According to this criterion, the radiosensitivity of the tumors obtained from a cellular predecessor from a post-irradiation tumor relapse is reduced with respect to that of tumors obtained with the primitive cellular predecessor. This suggests that the radioresistant cellular predecessors can appear in irradiated tumors. (tr-auth)

15672 FREE RADICALS IN RAT LIVER LIPIDS IN THE NORMAL STATE, AND AT VARIOUS PERIODS AFTER GAMMA IRRADIATION. I. K. Kolomiitseva, L. P. Kayushin, and A. M. Kuzin (Inst. of Biological Physics, Academy

of Sciences, USSR). Dokl. Akad. Nauk SSSR, 147: 951-3 (Dec. 1, 1962). (In Russian)

White male Wistar rats 250 grams in weight were given a whole-body dose of 1000 r of Cs^{137} gamma radiation. The livers of 3 to 4 rats were homogenized 5 minutes, 24 hours, 48 hours, and 66 hours after the irradiation, and the lipid fraction was extracted with a 3:1 mixture of alcohol and ether. A 100 mg sample was taken, and subjected to analysis for radicals by using the electron paramagnetic resonance method. The amount of radicals in liver lipids was found to be 5×10^{15} radicals per 100 mg of lipids, or 1×10^{-7} M radicals per 1 gram of lipids. On taking the amount of free radicals in the controls as 100%, it was found that the amount of free radicals was 178% 5 minutes after irradiation, 170% at 24 hours, 236% at 48 hours, and fell sharply to 64% at 66 hours after the irradiation. The total amount of lipids did not change during these periods. The amount of tracer acetate assimilated by the liver lipids varied in the same way as the concentration of free radicals in the liver lipids. Hence, the concentration of free radicals is related to the rate of lipid turn-over. (TTT)

15673 THE ROLE OF THE STATE OF THE THYROID GLAND IN THE ASTHENIC SYNDROME AFTER RADIATION SICKNESS. V. A. Rezontov and M. A. Lagun. Dokl. Acad. Nauk SSSR, 148: 700-1(Jan. 21, 1963). (In Russian)

In order to obtain information concerning the thermoregulation of an organism after radiation trauma, rats were exposed to γ radiation doses of 750 ($LD_{10/30}$) and 850 ($LD_{50/30}$) r. Five to 12 mg of thyroidin were administered twice daily to the surviving animals. At the end of the tests, the rats were infected with gas gangrene. The results indicated that the positive effects of the thyroidine are not due to a specific property of this hormone but is caused by the stimulation of the immunological reactivity of the rat's organism after being subjected to acute radiation sickness. Administration of the thyroidin promoted the regeneration of the resistance against infection to a greater extent in those cases when the resistance of the animal was especially low. It was concluded that exhaustion of the thyroid gland plays an important role in the pathogenesis of the postirradiation asthenic syndrome. (TTT)

15674 CHANGE IN CELL RESISTANCE TO ULTRAVIOLET RAYS EFFECTED BY THE PROPHYLACTIC ACTION OF DIBASOL AND DIMEZOL. F. L. Levin (Inst. of Cytology, Leningrad). Federation Proc., Transl. Suppl., 22: No. 2, Pt. II, T349-52(Mar.-Apr. 1963). (Translated from Tsitologiya, 4: No. 2, p.214-19(Mar.-Apr. 1962)).

Dibasol in a concentration of 1×10^{-5} to 1×10^{-6} and Dimezol in a concentration of 1×10^{-4}, like calcium chloride, raised the resistance of cells of the ciliated epithelium of pearly mussel gills to short-wave ultraviolet rays when used prior to irradiation. Under these conditions, Dimezol has a somewhat weaker effect than Dibasol. Dibasol and Dimezol, when used after irradiation, reduced the survival time of cells irradiated with ultraviolet rays. It was concluded that the injury of cells by short-wave ultraviolet rays and the prophylactic protective action of calcium chloride, Dibasol, and Dimezol under conditions of irradiation should be considered from the standpoint of the denaturation theory of injury. (P.C.H.)

15675 EFFECTS OF LOW-DOSE IRRADIATION AND STORAGE ON ACCEPTABILITY OF BROCCOLI, SWEET CORN, AND STRAWBERRIES. Dudley C. Martin and Doris A. Tichenor (Univ. of Kentucky, Lexington). Food Technol., 16: 96-100(Nov. 1962).

Fresh vegetables, in some cases stored in nitrogen, were γ irradiated with doses of 0.25 to 1.0 Mrad, then stored at 35°F, and evaluated for taste at various periods up to 305 days. All nitrogen-packed irradiated sweet corn was acceptable after 305 days, in contrast with unirradiated 35°F control samples, which were spoiled. One set of nitrogen-packed irradiated broccoli samples was acceptable after 270 days at 35°F; all others were unacceptable after this period. All of the irradiated strawberries were less acceptable than 35°F controls at all time periods. Correlation of objective color measurements with visual color scores varied with the product, but dominant wavelength, purity, or brightness was significantly related to color score for all products tested. Irradiation of strawberries resulted in bleaching of the characteristic red color, the amount of bleaching being greater at the higher dose levels. Samples irradiated at the higher levels had the lowest average dominant wavelength, closer to the orange area of the spectrum, and the lowest average purity. The pH of all strawberry syrup samples was between 3.1 and 3.5, and varied only slightly with blanching, radiation treatment, or time period. (H.H.D.)

15676 THE EFFECT OF VARIOUS SCREEN COMBINATION ON THE IRRADIATION TIME AND RADIATION BURDEN OF PATIENTS AT 60 TO 200 KV. H. Boesche (Universität, Goteborg). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 98: 92-6(Jan. 1963). (In German)

The exposure conditions and the doses which are required to obtain the same blackening with high-definition screens as with all-purpose screens under conditions prevailing in diagnostic practice in the 60 kv to 200 kv range were established. The increase of the gonad dose and the exposure factors were determined when high definition screens are used under practical conditions. The investigations show that the decrease of exposure obtainable with all-purpose screens is so limited that the use of high-definition screens is not restricted by this consideration. (auth)

15677 CONTRIBUTION TO THE BIOLOGICAL EFFECT OF 30-Mev ELECTRONS. T. Rudnicki (Inst. for Medical Physics, Academy of Medical Sciences, Poznan, Poland and Kantonsspitals, Zurich). Fortschr. Gebiete Roentgenstrahlen Nuklearmed, 98: 187-92(Feb. 1962). (In German)

Irradiation of the regenerating rat liver with 30-Mev electrons influences mitosis similarly to irradiation with 180-kev. The effect, which is caused by radiation injury of the cell at rest, takes a course which compares quantitatively and qualitatively. The radiation effects of 30-Mev electrons are slightly less marked and more quickly compensated than those of 180-kev x rays. 30-Mev electrons have a certain selective effect as they produce an initial increase of the prophase. (auth)

15678 EFFECTS OF X RADIATION ON THE TOXICITY OF PHARMACEUTICALS, WHICH AFFECT THE SYMPATHETIC NERVOUS SYSTEM FUNCTION. A. Danysz and T. Zaczek (Inst. of Pharmacology, Academy of Medical Sciences, Bialystok, Poland). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 98: 208-10(Feb. 1963). (In German)

The effect of x-irradiation (180 r) on the toxicity of certain plant substances on white mice was investigated. At the peak of the radiation effect the toxicity of pilocarpine, prostigmine, nicotine, and priscol was reduced and the toxicity of atropin and ephedrine was altered. (auth)

15679 RADIATION EFFECTS AND MITOTIC RECOMBINATION IN DIPLOIDS OF ASPERGILLUS NIDULANS. Etta Kaefer (McGill Univ., Montreal). Genetics, 48: 27-45(Jan. 1963).

Conidia from well-marked diploids of Aspergillus nidulans produce during vegetative growth abnormal colonies which regularly form better growing segregant sectors. The segregation patterns of such unstable colonies can be analyzed in detail by determining the segregation of markers in a large number of their stable sectors. A number of sectoring colonies, produced by treatment with high doses of γ-radiation, have been analyzed in this way and the segregation patterns of the treated colonies are compared to the various spontaneously occurring types. While evidence is obtained that the induced mitotic segregants are not the result of an increased frequency of the normal somatic segregation processes, the present analysis does not answer the question whether γ-radiation can increase mitotic nondisjunction or crossing-over in Aspergillus. The induced sectoring types are not aneuploids of the simple types such as are found spontaneously (mostly 2n + 1, 2n + 2, and less frequently n + 1 up to n + 4). The high frequency of sector forming types is, therefore, not likely to be due to a high frequency of nondisjunction, but possibly to a process which produces hemizygosis for chromosome parts (chromosome breakage). The patterns of segregation in the induced sectoring types are of an infinite variety and apparently involve both of the known processes of somatic recombination, mitotic crossing-over and nondisjunction. The observed new segregation patterns can usually be explained fairly simply by the assumption that the heavy radiation has produced a variety of chromosomal aberrations or semidominant lethals which can be repaired by an interplay of spontaneous somatic segregation and selection. It is, therefore, clear that this type of analysis does not so much provide direct information on the effects of radiation on somatic segregation, as on the types and frequencies of chromosomal aberrations produced by the treatment. It provides a genetic method of analysis of radiation effects in microorganisms which is comparable to cytogenetic studies in mitotic cells of higher plants or cultured mammalian tissues. (auth)

15680 SELECTION FOR RADIATION RESISTANCE IN MICE. Thomas H. Roderick (Roscoe B. Jackson Memorial Lab., Bar Harbor, Maine). Genetics, 48: 205-16(Feb. 1963).

From a four-way cross of inbred strains of mice, two separate selection experiments were performed: two-way selection for survival under 100 r/day of x rays and two-way selection for survival under 400 r/day of x rays. Selection was successful in both experiments but was much more pronounced under 100 r/day. A possible inverse relationship of intensity of stress and heritability is suggested. Body weight had a low positive phenotypic correlation and a high genetic correlation with survival under 100 r/day. Litter size was also a correlated response in both selection experiments. We conclude that body weight is not important per se in conferring greater resistance to irradiation but is rather a component of fitness in this genetically heterogeneous stock. Body weight is likely genetically correlated with radiation resistance because they are both components of fitness. It was not possible to establish whether an asymmetrical response in the selected trait had occurred, but it was apparent that the correlated response in body weight was in the low direction only. Possibly two-way selection has brought about a difference between the lines mainly through selection for a general lowered fitness in the low line alone. Females were found to be more resistant than males under 400 r/day, but the reverse was true under 100 r/day. (auth)

15681 DEVELOPMENTAL EFFECTS OF X-RAY INDUCED EUPLOID AND NEAR-EUPLOID MUTANTS IN HETEROZYGOUS CONDITION IN DROSOPHILA MELANOGASTER. I. DELAY IN EGG HATCHING AND LARVAL DELAY AND DEATH PRIOR TO PUPATION. Robert C. Baumiller (Saint Louis Univ.). Genetics, 48: 263-72(Feb. 1963).

D. melanogaster males were or were not treated with 3000 r of x rays, and the first released sperm were used to produce the F_1. The F_1 that hatched from the egg comprised the population studied with respect to time of egg hatching and delay and death prior to pupation. Results of the egg-hatching experiments were analyzed by two methods. By the first method the curves were compared with respect to only one extreme. This method showed a radiation-induced effect of about 6.1% more individuals delayed in time of egg hatching. The second method of analysis compared the total curves. By this analysis about 20% of the larvae showed a radiation-induced delay in time of egg hatching. Larvae which by the first method were undelayed egg hatchers, demonstrated approximately a 9.7% induced effect of delay in reaching pupation. The fact that this larval effect when added to the egg-hatching effect measured by the first method equals the total effect as determined by the second method, may or may not be accidental. Of the 9.7% of larvae which were late in pupation, about 69% fail to pupate. Among the larvae which were delayed in time of hatching, about 23.6% were again delayed in reaching pupation, and of these approximately 82% failed to pupate. The effects of delay and death studied here are attributed to euploid and near-euploid mutants in heterozygous condition. The basis for this conclusion is discussed briefly, as is the relation of these results to the detection of a heterotic effect of x-ray induced mutants. (auth)

15682 SEX CHROMOSOME TRANSLOCATIONS IN SPINACIA OLERACEA. Muneo Iizuka and Jules Janick (Purdue Univ., Lafayette, Ind.). Genetics, 48: 273-82 (Feb. 1963).

Chromosome 1 of Spinacia oleracea, the longest of the complement, contains the genetic factors controlling sex determination. This chromosome is normally heterobrachial with one arm twice as long as the other. A longer homobrachial variant of chromosome 1, due to an additional segment on the short arm, appears to involve a reciprocal translocation with chromosome 2. A reciprocal translocation involving the long arm of chromosome 1 and the long arm of chromosome 4 was induced with x rays. In crosses involving chromosome 1 marked with both translocations, the sex factors show close linkage with the translocation on the short arm, but show no linkage with the translocation on the long arm, indicating that the sex genes are located on the short arm of chromosome 1. The translocation on the long arm is associated with a mottled leaf character which is depressed by the presence of the translocation on the short arm. (auth)

15683 EXPERIMENTAL DATA ON THE EARLY RADIATION REACTION OF THE DIGESTIVE SYSTEM. II. CHANGES IN THE MICROMOTILITY OF THE SMALL INTESTINE IN ANIMAL EXPERIMENTS AS A RESULT OF GENERAL OR ABDOMINAL RADIATION EXPOSURE. A. Santha. Honvedorvos, 14: 305-16(Oct.-Dec. 1962).

Micromotility stops within a few hours after general or abdominal irradiation with doses of 200 to 800 r as shown in dogs. The stoppage is preceded by a transient stimulation, which may be avoided by antihistamine and ganglion-inhibitor treatment. Motility changes may be produced also in unirradiated dogs with crossed carotis circulation, explicable in terms of a transfer of so-called radiotoxins. If 0.1N HCl is introduced into the duodenum of the starved and irradiated donor animal, this will revive the micromotility

of both donor and acceptor within 16 to 24 hours of the irradiation even if complete paralysis had been produced. Up to 40 hr, the revival may be produced only in the acceptor animal. The ability to respond to hormonal stimulation disappears sooner in the animal suffering direct radiation damage. The clinical significance of the paralysis of micromotility is discussed in relation to early stages of radiation sickness. (OTS)

15684 THE CATABOLISM OF NUCLEIC ACIDS IN THE RAT. IV. THE REPLACEMENT OF DESOXYRIBONUCLEIC ACID IN THE IRRADIATED RAT. G. B. Gerber, G. Gerber, K. I. Altman, and L. H. Hempelmann (Univ. of Rochester, N. Y.). Intern. J. Radiation Biol., 6: 17-22 (Jan. 1963). (In English)

H^3-thymidine was injected into rats three days before x- or sham-irradiation. Alterations in synthesis and replacement of DNA after irradiation were estimated on the basis of the changes in specific activity of DNA one to three days after exposure. Urinary β-amino isobutyric acid was also isolated in order to gain insight into radiation-induced changes of the specific activity in the precursor pools of DNA. On the third day the specific activity of DNA was lower in spleen and thymus and higher in the intestine of x-irradiated animals than that of sham-irradiated animals. The specific activity of β-amino isobutyric acid was somewhat higher on the first day and lower on the second and third day after x-irradiation than that of sham-irradiated rats. The significance of these findings in terms of inhibition of DNA-synthesis, alterations in DNA replacement and destruction of cells is discussed. (auth)

15685 THE CATABOLISM OF NUCLEIC ACIDS. V. AUTORADIOGRAPHIC STUDIES ON THE REPLACEMENT OF DNA IN NORMAL AND X-IRRADIATED RATS. G. B. Gerber, W. G. Aldridge, G. Gerber, K. I. Altman, and L. H. Hempelmann (Univ. of Rochester, N. Y.). Intern. J. Radiation Biol., 6: 23-38(Jan. 1963). (In English)

Rats were injected with H^3-thymidine and three days later exposed to 500 r and 1000 r whole-body x irradiation. The animals were sacrificed at various times after exposure and autoradiographs were prepared from spleen, thymus, testis, intestine, adrenals, liver, kidney, and muscle. Autoradiographs were also prepared from a group of non-irradiated rats at different intervals after injection of H^3-thymidine. Extensive cell-destruction with subsequent phagocytosis of labeled nuclear debris by macrophages was observed in spleen and thymus. Cell and DNA-replacement was inhibited in the intestine, and the maturation of spermatogonia to primary spermatocytes seemed to be delayed in the testes of x-irradiated rats. Other organs of x-irradiated rats showed no significant alterations in their labeling pattern. (auth)

15686 GENETIC EFFECTS OF CHRONIC LOW-DOSE IRRADIATION ON MICE. Susumu Muramatsu, Tsutomu Sugahara, and Yoshiko Okazawa (Inst. of Radiological Sciences, Chiba, Japan and Kyoto Univ.). Intern. J. Radiation Biol., 6: 49-59(Jan. 1963). (In English)

The genetic effects of radiation on mice were studied by applying chronic gamma-irradiation from conception to reproduction for three successive generations. The frequency of autosomal recessive lethals estimated by Haldane's method, litter-size, rate of early death, and sex-ratio were compared for the offspring of irradiated and non-irradiated ancestors. The dose-rate used was as low as 0.43 r/22 hr-day, and the accumulated dose for each generation was about 34.4 r. A significant difference was observed in some of the above points. The rates of mutation to various kinds of recessive lethals were calculated. The genetic effect of radiation on mice was demonstrated at a low dose with a low dose-rate. The results may be very significant for the assessment of human radiation hazards. (auth)

15687 INFLUENCE OF METHIONINE SULPHOXIMINE AND X-IRRADIATION ON THE RADIOPOTASSIUM ^{42}K CONTENT IN RATS. Jaroslav Koloušek and Miloslav Raković (Charles Univ., Prague). Intern. J. Radiation Biol., 6: 61-7(Jan. 1963). (In English)

The content of radiopotassium K^{42} in various organs and in the blood and serum was studied in rats, both after total-body irradiation with 1000 r x rays and after the administration of a single dose of L-methionine sulfoximine (150 mg/kg body-weight), and compared with that in controls given radiopotassium alone. After irradiation and after the administration of L-methionine sulfoximine, a diminution of the radiopotassium content in the thymus and in the pancreas was noted, compared with controls. The administration of L-methionine sulfoximine was followed by an increase of the K^{42} content in the adrenals, which was not observed after exposure to x radiation. Both x rays and the administration of L-methionine sulfoximine were followed by a marked increase of the radiopotassium content in the kidneys. The changes of the radiopotassium content in various organs of the rat observed in our studies after x radiation and after a single dose of L-methionine sulfoximine were, to a certain degree, analogous. (auth)

15688 RADIOSENSITIVITY OF SELECTED SUB-LINES OF A TUMOUR-CELL POPULATION TESTED IN THE PRESENCE OR ABSENCE OF OXYGEN. Ulla Glas and László Révész (Karolinska Inst. Medical School, Stockholm). Intern. J. Radiation Biol., 6: 69-80(Jan. 1963). (In English)

The radiosensitivity of two sub-lines, one hyperdiploid (ELD), the other hypertetraploid (ELT), derived from the same original ascites-tumor cell population, was compared, using two different criteria of radiation injury. Determinations were made in diffusion chambers of either the size of the total cellular content, or the proportion of viable to non-viable cells according to their eosin stainability, at intervals after exposure to single doses of x rays, in an oxygen or nitrogen atmosphere, covering the range 300 to 4000 r. After irradiation in a nitrogen atmosphere, the hyperdiploid was found to be more sensitive than the hypertetraploid sub-line. In oxygen, however, no such difference in sensitivity was demonstrated, though the sensitivity of both sub-lines was increased, implying a different oxygen-enhancement for cells of different chromosome content. The authors discuss whether this difference of enhancement could be due to differences between the sub-lines associated with the doubling of the genera, or whether it could indicate that the radiation injury in oxygen is qualitatively as well as quantitatively different from that produced in nitrogen. It is suggested that the presence of oxygen might mask a sensitivity difference demonstrable by radiation exposure under anaerobic conditions. (auth)

15689 THE INFLUENCE OF IONIZING RADIATION ON NUCLEIC ACIDS, VITALITY AND FECUNDATING ABILITY OF MALE SEXUAL CELLS. Miroslav Valenta (Lab. for Biological Reproduction, Libechov, Czechoslovakia), Jaroslav Koloušek, and Josef Fulka. Intern. J. Radiation Biol., 6: 81-91(Jan. 1963). (In English)

The influence of various kinds (x,β,γ) and doses (10, 50, 100, 500, 1000, 2000, 5000, 10 000, 20 000, 30 000, 50 000, 100 000, and 150 000 r) of ionizing radiation on male sexual cells of some domestic animals (bull, ram, rabbit, dog) and man was measured. Vitality and mobility of the sperms are substantially affected only by irradiation with doses of

the order of 10^3 and 10^4 r. Changes in the fecundating ability and in the content of nucleic acids are ascertainable already at 10^2 to 10^3 r doses. Based on these observations the hypothesis is formulated that changes in nucleic acids evoked by radiation in sperms used for insemination are one of the main causes both of increased embryonal mortality and of complete inability of fecundating female sexual cells with irradiated sperms. The changes in the content of nucleic acids, and especially the possibility of Na-synthesis in an early period after irradiation of the sperms and their subsequent degradation, are still under study. (auth)

15690 CONCERNING THE MECHANISM OF THE INCREASED RNAse ACTIVITY IN LYMPHATIC CELLS FOLLOWING WHOLE-BODY IRRADIATION. Dalia Maor (Weizmann Inst. of Science, Rehovoth, Israel and Israel Atomic Energy Commission, Rehovoth) and Peter Alexander. Intern. J. Radiation Biol., 6: 93-103(Jan. 1963). (In English)

The RNAse content (i.e., total enzymatic activity after removal of inhibitors and disruption of mitochondria) was measured at 4, 28, and 48 hrs after whole-body irradiation with 400 and 1000 r in a number of organs of the rat. No changes were observed in the liver and kidney, and only small changes in the brain. In spleen, the activity of the organ as a whole did not rise, but the concentration per cell increased up to four times. In the thymus, the RNAse activity of the whole organ went up, and because of the large cell destruction this meant that the activity per cell in the irradiated organ increased as much as four hundred times after 1000 r. The new cells which repopulate the thymus and spleen at nine days after 400 r have normal RNAse contents. The increase of the RNAse content per cell in the spleen following whole-body radiation seems to be an abscopal effect due to the irradiation of the head of the animal, because the same increase in RNAse is obtained when only the head is exposed, while a small increase only is found if the head is shielded, but the rest of the body irradiated. In the thymus abscopal factors also play a part in the increase in RNAse; head shielding reduces the increase in RNAse per cell to a small fraction of that found after whole-body irradiation, but does not entirely prevent it. Irradiation of the head only increases the RNAse content of the thymus, but not to the same extent as whole-body irradiation. Cell destruction in both the spleen and thymus is not affected by head shielding and the same loss in weight and DNA-content occurs as for whole-body irradiation, and the increase in RNAse cannot therefore play an important role in the interphase death of the lymphatic cells in spleen and thymus. It is suggested that the increase in RNAse of the cells that survive radiation is due to increased synthesis induced by radiation stimulation of the neuro-endocrine system. (auth)

15691 A CASE OF HEMANGIOMA OF THE LIVER 25 YEARS AFTER AN INJECTION OF THOROTRAST FOR CEREBRAL ANGIOGRAPHY. L. R. Vellenga (Havenziekenhuis, Rotterdam). J. Belge Radiol., 45: 682-8(1962). (In Dutch)

Description of a case of hemangioma of the liver caused by thorotrast injection performed 25 years before is presented. Diagnosis was made after proof-excision of the liver during a laparotomy. An extensive discussion is given on cases of malignity after thorotrast. (P.C.H.)

15692 ON THE SUBJECT OF THE INFLUENCE OF RIBONUCLEIC ACID OF YEAST ON THE LEUKOCYTE LEVEL IN THE CIRCULATING BLOOD IN THE RAT IRRADIATED "IN TOTO." P. Bassi and A. Dunjic (Universite, Louvain, Belg.). J. Belge Radiol., 45: 747-53(1962). (In French)

In the rat, an intraperitoneal injection of 500 mg ribonucleic acid, after a whole-body irradiation of 400 r roentgen rays, determines a more rapid regeneration of white cells and especially of neutrophiles in the peripheral blood. The same injection in the non-irradiated rat increases the neutrophiles figures up to twice the normal values. Discussion is given on the probable mechanism of the nucleic acids on the regeneration of white cells in irradiated animals. (auth)

15693 EFFECTS OF X IRRADIATION OF DIFFERENTIATING LEYDIG CELLS OF THE IMMATURE RAT. P. G. Wall (Univ. of Birmingham, Eng.). J. Endocrinol., 23: 291-301(Dec. 1961).

Experiments were designed to determine whether x irradiation affects subsequent production of androgen, whether subsequent response of testis to gonadotropin is impaired, and whether accessory sex organs are affected. Male rats were exposed to 400, 800, or 1200 r at varying ages after birth (3 to 36 days). The subsequent secretory capacity of the testis, as judged by the weight of the accessory sex organs, was markedly impaired following irradiation. The effect of x irradiation on the secretory interstitial (Leydig) cells depended on both the dose of x rays used and the age of the animals at the time of exposure. The reduction in the secretion of androgen was associated with a decrease in the volume of intertubular tissue. The secretory cells became progressively more radioresistant as the animals neared the age of puberty. The ability of Leydig cells to respond to exogenous gonadotropin was diminished by irradiation. In contrast, the response of the accessory sex organs to exogenous androgen was not appreciably affected. The observations suggest that: the Leydig cells of the immature animal may be more radiosensitive than those of the adult; irradiation may modify the response of interstitial cells to gonadotropin; and destruction of the seminiferous epithelium may induce an imbalance in the levels of endogenous gonadotropins. (H.H.D.)

15694 BIOCHEMICAL STUDY OF THE MITOTIC INHIBITION IN RAT SKIN RESULTING FROM BETA RADIATION. I. A. Bernstein and Phyllis Foster (Univ. of Michigan, Ann Arbor). J. Invest. Dermatol., 39: 461-6(Nov. 1962).

Exposure of newborn rats to 25-rad whole-body β radiation resulted in complete inhibition of mitosis for 2 hr in the germinative layer of the epidermis and in the hair follicles. A dose of 50 rad extended the inhibitory period to 4 hr. When cell division resumed, there was a brief period of abnormally high mitotic activity followed by a return to the normal rate. Animals exposed to a single dose of radiation, however, showed no obvious residual effects when observed over a period of several months. A level of radiation (25 rad) which temporarily inhibited mitosis in the skin of newborn rats for 2 hr, had no observable effect on the incorporation by skin of P^{32} given immediately postirradiation. A higher level of radiation (50 rad) equally affected the incorporation of P^{32} into both RNA and DNA in skin. P^{32} incorporation was depressed if the tracer was administered immediately postirradiation and increased if the P^{32} was given 2 hr prior to radiation. The results indicate that nucleic acids are not the site of the primary inhibitory effect of 50-rad β irradiation and are apparently not grossly affected by 25 rad, which is sufficient to inhibit mitosis. (P.C.H.)

15695 EFFECTS OF ALPHA PARTICLE RADIATION ON THE RAT BRAIN, INCLUDING VASCULAR PERMEABILITY AND GLYCOGEN STUDIES. Igor Klatzo, (National Inst. of Neurological Diseases and Blindness, Bethesda,

Md.), Jaime Miquel, Cornelius Tobias, and Webb Haymaker. J. Neuropathol. Exptl. Neurol., 20: 459-83(Oct. 1961).

Dorsal parts of rat cerebrum and cerebellum were exposed to alpha radiation (12 Mev per nucleon) from a 60-in. cyclotron at a brain surface dose of 6000 rad (a Bragg-peak dose of 30000 rad). The animals were sacrificed at time intervals from 5 min to 5 months and the brains were subjected to various techniques, including fluorescein-labeled serum protein (FLSP), sodium fluorescein (NaFl), and other procedures for assessment of vascular permeability. Histochemical methods were employed for evaluation of changes in brain tissue components, especially for demonstration of glycogen. The results suggest that alpha-particle energy exerts an injurious effect on cellular elements primarily according to its physical properties and distribution in the tissue and that the vascular permeability disturbances play a secondary role. Also from the appearance of glycogen in glial cells, the possibility is suggested that disruption of protein-bound tissue glycogen due to radiation injury may lead to its liberation and subsequent uptake by the glial cells, presumably by pinocytosis. (P.C.H.)

15696 HEMATOLOGIC CHANGES OBSERVED FOLLOWING I^{131} THERAPY FOR THYROID CARCINOMA. Thomas P. Haynie and William H. Beierwaltes (Univ. of Michigan, Ann Arbor). J. Nucl. Med., 4: 85-91(Mar. 1963).

Two hundred patients received therapy doses of I^{131} for thyroid carcinoma in the interval 1947 to 1960. Follow-up evaluations of the peripheral blood were made at three months and at yearly intervals up to ten years after completion of therapy in 159 patients. The most common abnormality observed in the peripheral blood count after I^{131} therapy was a subnormal hemoglobin concentration seen in 36% of the patients. Subnormal white blood counts were seen in about 10% of the patients, and thrombocytopenia was seen in only five cases (3%). These changes were roughly correlated with the total dose of I^{131} in that those who had blood abnormalities noted after treatment received about twice the mean total dose of those who did not experience abnormality. In addition, the extent of metastatic disease and the administration of preceding x-ray therapy were of importance in producing blood changes after I^{131}. These changes were of brief duration, for the most part lasting less than one year, and were not symptomatic. No cases of leukemia or aplastic anemia have been observed to date. (auth)

15697 LONG TERM EXPERIENCES WITH THE USE OF P^{32} IN THE TREATMENT OF CHRONIC LYMPHOCYTIC LEUKEMIA. Ruth C. Steinkamp, John H. Lawrence, and James L. Born (Univ. of California, Berkeley). J. Nucl. Med., 4: 92-105(Mar. 1963).

A series of 161 patients with chronic lymphocytic leukemia, (C.L.L.), 30 (18.6 per cent) of whom have survived from 10 to 31 years after onset, is presented. Twenty of these long-survival group patients are still living. Survival times were calculated from onset of symptomatology or diagnosis in asymptomatic cases; diagnosis; and first visit to Donner Laboratory. Analysis of symptomatology, physical findings, and laboratory data at the time of diagnosis for the 2 groups indicates that there is no absolute measure for prognosis. The important conclusion from this study re-emphasizes the fact that the diagnosis of C.L.L. can be compatible with many years of useful life and should bring reassurance to both doctor and patient that the disease follows a relatively benign course in an appreciable number of cases. Therapy was primarily with P^{32}. No cases of acute leukemia were observed nor was the incidence of malignancies increased as a result of treatment. No other sequelae were encountered that would contraindicate the use of radiation. Pneumonia as a cause of death was significantly higher for the group dying before 1948, while for the same interval coronary disease or its sequelae was responsible for death in a percentage less than half that of the later period. While hemolytic complications may develop at any stage of C.L.L., they tended to occur more frequently in those patients in whom the course had been long and slowly progressive. Subjective and objective improvement occurred in those patients treated with oral androgens. Further work is indicated to associate a direct leukemic suppressive effect. Comparison of future studies would be facilitated if survival statistics are determined by some method similar to that used in this series. (auth)

15698 RADIOAUTOGRAPHY, PRINCIPLES AND PROCEDURES. David L. Joftes (New England Deaconess Hospital, Boston). J. Nucl. Med., 4: 143-54(Mar. 1963).

Principles and basic procedures are outlined for the preparation of radioautograms. It is concluded that the dipping method of radioautography is simple and flexible. Modifications may be used depending on experimental conditions. (C.H.)

15699 A CHROMATOGRAPHIC STUDY OF THE STABILITY OF IODINE-131 LABELED SODIUM O-IODOHIPPURATE. Leopoldo J. Anghileri (Volk Radiochemical Co., Skokie, Ill.). J. Nucl. Med., 4: 155-8(Mar. 1963).

Solutions of sodium o-iodohippurate-I^{131} (Hippuran) are widely used as a radioisotopic diagnostic agent in kidney function studies. Studies were made on the stability of the radioactive material under various conditions of pH, salt concentration, and time. Results indicate that the stability of Hippuran solutions decreases as the initial specific activity of the product is increased. (C.H.)

15700 THE EXCRETION OF Na^{22} IN SWEAT. H. W. Weigel, J. Parsons, H. Elrick, C. J. Hlad, Jr., and E. Miller (Veterans Administration Hospital, Denver and Univ. of Colorado, Denver). J. Nucl. Med., 4: 159-61(Mar. 1963).

A new method for measuring sodium excretion in sweat, utilizing Na^{22}, is described. The physical characteristics of the radioisotope are very favorable and the test procedure is simple. The method has been applied to 50 control subjects, 20 patients with chronic lung disease, and 4 patients with fibrocystic disease of the pancreas. The results show a significant elevation of sweat Na^{22} excretion in patients with chronic lung disease, but not to the degree seen in patients with cystic fibrosis of the pancreas. These findings are compatible with the concept that some patients with chronic lung disease may have a form of pancreatic fibrosis not clinically detectable. (auth)

15701 BIOPHYSICAL INTERPRETATION OF THE BIOLOGICAL ACTIONS OF RADIATIONS. I. CORRESPONDENCE BETWEEN THE RELAY-CONTACT SYSTEM AND THE GENE-ENZYME SYSTEM AND SOME DISCUSSIONS ON THE TARGET THEORY. Y. Nishiwaki (Tokyo Inst. of Tech.). J. Radiation Res. (Japan), 2: No. 1, 42-60 (1961).

From analogy between the complex gene-enzyme system governing the metabolic current in the cell and the complex electric switching circuit system governing the electric current, the induction of mutation may be compared to the blocking or alteration of different parts of the switching system at random by mutagenic agents or by the action of radiations. On the basis of the results of analysis of such a complex system, more general types of the multi-target hit functions are introduced, and some special cases, which may be useful in the analysis of the dose-survival and the

dose-effect curves, are discussed. Under conditions where the effective action field of radiation is large in comparison with the mean separation of the unit target switches, a major part of the complex switching system in the cell may be blocked or altered simultaneously by a single hit of radiation and it may appear as if there exists only a single target in the cell. With the reduction of the effective action field of radiation the dose-survival curve may have a tendency to become a sigmoid type and may be approximated by a more complex type of hit functions corresponding to the apparent internal structure of the cell explicit under the conditions of the experiment. (Abstr. Japan Med., 2: No. 12, Dec. 1962).

15702 THE X-RAY DOSE ABSORBED BY SOFT TISSUE NEAR A BONE. M. Hosoe (St. Paul's Univ., Tokyo). J. Radiation Res. (Japan), 2: 68-84(1961).

A method of measuring the distribution of the absorbed dose of x rays near a plane boundary of two kinds of medium is presented as it was applied to the measurement of the dose distribution in soft tissue adjacent to bone. R, the ratio of D_0 (the dose absorbed by soft tissue immediately adjacent to bone) to D_∞ (the dose absorbed by soft tissue away from bone), was determined experimentally by this method and was compared with the theory, which is based on the Bragg-Gray cavity principle. Comparison with the experimental findings showed that both theories, which do not take into consideration the difference of electron scattering in different kinds of medium, fail to elucidate the actual dose distribution near the boundary of two media. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

15703 BIOPHYSICAL INTERPRETATION OF THE BIOLOGICAL ACTIONS OF RADIATION. II. EXAMPLES OF TYPE-ANALYSIS OF DOSE-SURVIVAL AND DOSE-EFFECT CURVES. Y. Nishiwaki (Tokyo Inst. of Tech.). J. Radiation Res. (Japan), 2: 98-123(1961).

On the basis of the analysis of the metabolic switching circuit function with symbolic logic or Boolean algebra and the multi-target theory, some examples of type-analysis of dose-survival curves of E. coli and phages and theoretical discussions on the dose-effect or dose-mutation curves are presented. The delayed expression of mutation, photoreactivation, or photoreversal of mutation, and the phenomenon that the mutation rate among the survivors increases first with the increase of the dose of radiation but reaches a peak or plateau and sometimes begins to decrease, are also discussed. From the exponent of e in the hit functions the average size of the unit particles or target switches may be estimated. In the case of inactivation of E. coli or phages by x rays the size of the unit particles appears to approach closely to that of the macromolecule of DNA with reduction of the effective action field of radiation, which in the case of uv light some smaller unit equivalent to about 1 to 20 nucleotides appears to be playing a role of primary importance. Although it appears to be smaller with the radioresistant than with the radiosensitive strain, the size of the unit particle for uv light of wavelength 2537 Å appear to be equivalent to about 10 to 20 nucleotides with the radiosensitive strain and with correction for the attenuation factor inside the cell. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

15704 SPERMATOGENESIS OF RATS INJECTED WITH RADIOACTIVE CAESIUM 137. T. Kitabatake (Nagoya Univ., Japan). J. Radiation Res. (Japan), 2: 124-30(1961).

A solution of Cs^{137} was intraperitoneally injected into rats, and a quantitative examination was made of their spermatogenesis. For making calculation simple and arriving at a ready conclusion, the germ cell tubulus ratio or more shortly the germ cell ratio method was used. The germ cell ratio is the proportion of seminiferous tubules having spermatogonia, spermatocytes, spermatids, and sperm cells to all seminiferous tubules in the same section of the testis. After the administration of 5, 50, and 200 μC of Cs^{137} the animals were sacrificed at various time intervals. The germ cell ratio of each type of germ cells was significantly decreased, particularly in the 200-μC-injected group. Even in the 5-μC-injected animals, diminution of the germ cell ratio of each type of germ cells was slight but statistically significant with exception of the sperm cells which maintained a constant level of about 90 to 100% throughout the observations. It was estimated that the animals in the 5-μC-group received a radiation dose of no more than 10 rad from internally administered Cs^{137}. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

15705 THE EFFECT OF X-IRRADIATION ON 5-HYDROXYTRYPTAMINE (SEROTONIN) CONTENTS IN THE SMALL INTESTINES OF EXPERIMENTAL ANIMALS. Osamu Matsuoka (National Inst. of Radiological Sciences, Chiba, Japan), Takehiko Tsuchiya, and Yoshinori Furukawa. J. Radiation Res. (Japan), 3: 104-8(June 1962). (In English)

The effects of x radiation (500 to 2000 r whole-body) on 5-hydroxytryptamine (5-HT) contents of small intestine was studied in rats, mice, guinea pigs, and rabbits. In order to examine the relation between the effect on 5-HT contents and intestinal injury by radiation, mean survival time and incidences of diarrhea were also observed in each species following irradiation. The 5-HT contents of the small intestine were remarkably reduced by exposure. The depressed level of 5-HT continued 48 hrs. There were great differences in normal contents of 5-HT and the reduction rate after exposure among these species. It was found that the species that have high 5-HT contents and large reduction rate after exposure were sensitive to radiation. The radiosensitivity of the intestine seemed to be closely related to its endogenous 5-HT. Its possible relation is discussed. (auth)

15706 STUDIES ON THE DEOXYRIBONUCLEOPROTEIN OF MOUSE SPLEEN IRRADIATED WITH ^{60}Co γ-RAYS. Ichijiro Honjo (Osaka Univ.), Atsuhiko Takeda, and Toshio Maeda. J. Radiation Res. (Japan), 3: 130-9(June 1962). (In English)

Studies on the extirpated spleen showed that an increase in the amount of 0.14 M NaCl-soluble DNA was independent of the conditions of irradiation but dependent on those of incubation. (auth)

15707 CYTOPATHOLOGICAL STUDY ON THE EFFECT OF P^{32} AND Lu^{177} UPON HeLa CELLS. Y. Hazama (Keio Univ., Tokyo). Keio Igaku, 38: 211-33(1961).

Two radioisotopes, Lu^{177} and P^{32}, in doses ranging from 0.007 to 0.3 and from 0.001 to 0.2 μC-cu.cm, respectively, were added to cultures of HeLa cells. With Lu^{177}, typical changes due to radiation, such as swelling, enlargement, vacuolization, and degeneration, were observed. With higher doses of irradiation more swelling of cells and more giant cells were noted. The changes were prominent with doses of more than 0.15 mC. Cells smaller than normal were less numerous than giant cells after high doses of irradiation. The giant cells were most often mononuclear, and di- and tri-nuclear cells were more numerous than those with more than 4 nuclei. With P^{32}, atypical radiation effects were observed: rounding, swelling, and enlargement; the mitotic index was low, and vacuolization was scarce. Swelling and enlargement appeared cyclically at intervals of 2 to 3 days,

more frequently as the dose of irradiation increased. Smaller than normal cells appeared on the 4th day of P^{32}-irradiation and were most numerous on the 7th day. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

15708 QUANTUM CHEMICAL EXPLANATION OF THE RADIATION EFFECT. J. Barany. Magy. Radiol., 14: 360-9(Dec. 1962).

The insufficiency of the target theory of physics is discussed as it may be applied to biological systems. It is stressed that radiation effects result not only from the ionization, which ensues upon radiation, but also from chemical changes, which might be brought about as a consequence of radioinduced fragmentation of molecules followed by the recombination of such fragments to yield different molecules. Such changes may occur in the water of the cells and also in the proteins which catalyze biological processes. Metabolic disturbances and even cellular destruction may result. (OTS)

15709 HYPERTONIA, NEPHRITIS, AND NEPHROFIBROSIS (CIRRHOSIS) AFTER IRRADIATION OF THE KIDNEY. H. Sarre and F. Moser (Medizinischen Universitäts-Poliklinik, Freiburg i. B.). Med. Klin. (Munich), No. 36, 1526-30(1962). (In German)

From animal experimental studies and observations on irradiated patients, a subdivision of the irradiation consequences into three groups was made, which considered the clinically establishable different results as a result of the irradiation dose. Irradiation hypertonia which was interpreted as renal hypertonia was the first subdivision. It occurs after irradiation of one or both kidneys with doses from 500 to 2000 r. The injuries to the renal tissue, which are slight and partially reversible, first occur after hypertonia. The second subdivision is irradiation nephritis, in which after irradiation of the whole kidney tissue with average doses of 2300 r (up to 3000 r) a hypertonia and a heavy radiation injury to the kidney parenchyma occurs. The course of the sickness was determined by the combination of hypertonia and kidney damage. Irradiation fibrosis or cirrhosis (the third subdivision) is indicated by a severe, irreversible, and progressive radiation damage of the kidney parenchyma with lethal results in uremia. Hypertonia was not present or has at least no pathogenetic significance. (tr-auth)

15710 TREATMENT OF RADIATION INJURIES OF THE BLADDER WITH ALBOTHYL INSTILLATION. H. Bunka. Med. Klin. (Munich), No. 44, 1868-9(1962). (In German)

The instillation treatment of Albothyl (patented trade name of a condensation product of metacresol sulfonic acid and formaldehyde) is a successful, simple, and inexpensive method for the treatment of severe chronic radiation injuries of the bladder accompanied by massive macrohematuria. This can be carried out during office hours without large time, instrumentation, and material expenditures. (tr-auth)

15711 ABDOMINAL FUSIFORM SARCOMA AFTER THOROTRAST. W. Krick and G. Heck. Med. Klin. (Munich), No. 45, 1899-1901(1962). (In German)

In a 67-year old man, an intra-abdominal fusiform cell sarcoma developed twenty years after thorotrast application by arteriography of the right leg. Thorotrast deposition was detected by x rays in the liver and spleen. The sarcoma had affected the omentum, the mesentery, and the intestinal fluid, penetrated the pancreas, and formed a retroperitoneal tumor with involvement of the left adrenal gland and fine and coarse nodular depositions in the liver. A significant thorotrast storage was detected microscopically in the liver and to a small extent in the kidney. Thorotrast was detectable at the perimeter of the tumor site in the liver. Pigmentation inclusions in the tumor cells could not be detected. In critical evaluation of these findings, the present case partially fulfills the hypotheses for the recognition of a tumor originating from thorotrast effects. The latency time of 20 years corresponds to the assumption made by Bauer on thorotrast sarcomas. The malignant character of the new formation was proved. Other factors for the tumor development without a relationship to the thorotrast application was not established. The findings are therefore positive for the question of the relationship between thorotrast application and expected tumor development. In spite of the detection of thorotrast precipitations in the perimeter of the tumor site in the liver, it is not proved, in the complete localization of the tumor, that the position of the contrast medium precipitation is connected with the site of the tumor origin. For a positive relationship, the data must be evaluated with the reservation that the sarcoma first appeared in a patient at the advanced age of 67. (tr-auth)

15712 RENAL LESIONS FROM IONIZING RADIATION. I. OBSERVATION ON THE ULTRASTRUCTURE OF GLOMERULUS AND PROXIMAL TUBULE IN THE MOUSE TOTALLY IRRADIATED WITH A LOW DOSE OF X RAYS. A. Pasinetti, G. Poggi Longostrevi, and L. Lombardi (Università, Milan). Minerva Nucl., 6: 333-40(Nov. 1962). (In Italian)

A study was made of the ultramicroscopic features of the glomerulus and proximal tubule of the kidney of mice subjected to a single dose of x rays. A whole-body radiation with only 50 r was found to be sufficient to cause ultramicroscopic structural changes. The cellular damage in the foot cells was confined to the cytoplasm and could not be demonstrated by the 21st day. In the cells of the proximal tubule the lesion affected mainly the mitochondria (tendency to agglutination and fall in number of crests) and 3 weeks after treatment was still demonstrable, although to a lesser extent (swelling of mitochondrial body). The changes, although reversible, are of some importance since they involve functionally significant renal elements. (auth)

15713 RENAL LESIONS FROM IONIZING RADIATION. II. OBSERVATION ON THE ULTRASTRUCTURE OF DISTAL TUBULE OF THE MOUSE TOTALLY IRRADIATED WITH A LOW DOSE OF X RAYS. G. Poggi Longostrevi, A. Pasinetti, and L. Lombardi (Università, Milan). Minerva Nucl., 6: 340-3(Nov. 1962). (In Italian)

An electron microscopic study was made of the region of the distal tubule of the kidney in mice subjected to small doses (50 r) of whole-body x irradiation. Changes in the cytoplasm of cells from the thick ascending part were noted. The ground substance became rarefied especially in the perinuclear area. With regard to the mitochondria, microscopic structural changes were not uniform as they were in the proximal tubule but varied considerably from cell to cell. Large mitochondria with constant central rarefaction and numerous optic spaces although with crests in a fairly good state of preservation, were noted, as well as mitochondria that did not present a recognizable well-defined microscopic structure. Although the cytoplasmic changes, demonstrable 24 hr after whole-body irradiation, returned to normal by about the 7th day, the normalization of mitochondrial morphology occurred much later. (auth)

15714 FIRST IMPORTANT BIOLOGICAL STUDIES ON INHERENT INFILTRATIVE INTERSTICES OF NEOPLASTIC MALIGNANCIES IN MAN WITH NEW COMPLEX COLLOIDS LABELED WITH P^{32}. L. Caldarola (Istituto di Oncologia,

Turin), F. Badellino, A. Cavalli, P. Calderini, B. Bellion, U. Rosa, R. Sosi, and U. Orsello. Minerva Nucl., 6: 385-6 (Dec. 1962). (In Italian)

Twenty patients with infiltrative malignant tumors were treated with a P^{32} labelled colloidal compound. Radioactivity values in blood, urine, and stools illustrate the stability of the radio-colloid as well as its high uptake in infiltrated tissues. Reference is also made to the labeling of the radio-colloid with Cr^{51}, an emitting tracer. (auth)

15715 FIRST EXPERIMENTAL RESULTS ON THE ACTIVITY OF THE RETICULO-ENDOTHELIAL SYSTEM INVESTIGATED, IN VIVO, BY MEANS OF SCINTILLATION TECHNIQUES WITH RADIO-GOLD COLLOIDS. D. Giordano, R. Pantaleo, and S. Salamanna (Università, Bari, Italy). Minerva Nucl., 6: 387-91(Dec. 1962). (In Italian)

The possibility of demonstrating the reticulo-endothelial system of bone marrow was revealed in studies carried out on the rabbit by means of a scintillation counting method, following intravenous injection of colloidal Au^{198}. The experimental technique with regard to the physical features and minimum effective dose (400 mc/Kg) for a clear, well-contrasted scintigram, without toxic doses deing reached, is described. (auth)

15716 CHANGES IN THE ASCORBIC ACID CONTENT OF SEEDS OF VICIA FABA INDUCED BY BETA RADIATION. M. Z. Barakat, M. F. Abdel-Wahab, and Sami A. El-Kinawi (Cairo Univ.). Monatsh. Chem. 93: 754-60 (1962).

The ascorbic acid content of 3 strains of seeds (Rebaya 34, Giza I, Giza II) was determined during germination after exposure to β radiation. The dried seeds (100 g) were added to 500 ml water containing 100 μc P^{32} (as H_3PO_4, with a specific activity of 1 mc/mg P), incubated for 48 hr, and allowed to germinate for 30 days. The P^{32} uptake of the seeds varied from 0.26 to 0.49 μg/100 g. The ascorbic acid content of the dry seeds was very low (<1 mg/100 g), but increased markedly during germination, up to a maximum of ~25 mg/100 g on the 20th day of germination. P^{32} treatment significantly diminished the ascorbic acid content of the germinating seeds, particularly those of the Giza I strain, in which the content was 70% below normal on the 12th day of germination. In contrast to the depressed formation or accelerated catabolism of ascorbic acid in seeds exposed to low doses of P^{32}-emitted β radiation, irradiation did not appreciably affect germination of the seeds. (H.H.D.)

15717 RADIATION CATARACTOGENESIS. Sidney Lerman (Univ. of Rochester, N. Y.). N. Y. State J. Med., 62: 3075-85(Oct. 1, 1962).

The pathological effects of various types of radiation, ranging from radio waves to cosmic rays, on the eye are considered. Neutrons, roentgen rays, and gamma rays possess the most serious cataractogenic potential. The cataracts produced by these 3 forms of radiation are similar in appearance and structure, consisting initially of posterior subcapsular and cortical opacities, requiring latent periods before becoming visible, and occurring with doses that do not necessarily produce any other clinically evident lesions. One of the earliest chemical changes observed in the lens following exposure to x radiation is a rapid fall in the level of sulfhydryl groups. Irradiation of rats causes a marked (50 to 100%) increase in the turnover of albuminoid RNA as measured by P^{32} incorporation. Turnover of albuminoid RNA usually returns to relatively normal limits by the second or third week. The lactic acid content in the lens begins to decrease at the third to fourth week postirradiation, and a decline in the activity of glucose-6-phosphate dehydrogenase, as well as of some of the glycolytic enzymes, becomes manifest shortly thereafter. (P.C.H.)

15718 KILLING EFFECT OF ^{60}Co GAMMA RAYS AND ACQUIRED RESISTANCE OF BACILLUS ANTHRACIS BY SUCCESSIVE IRRADIATION. Isao Yoshida, Katsuji Sugimura, and Mitsuaki Hayashi. Natl. Inst. Animal Health Quart., 2: 207-15(1962). (In English)

The survival curves of Bacillus anthracis and B. cereus spores after exposure to γ-irradiation were of sigmoid type. The perfectly lethal dosage of γ-rays was 180×10^4 r in B. anthracis and 210×10^4 r in B. cereus. The killing effect was dependent upon the dose rate and showed a tendency to lessen in the condition of high dose rate. The resistance of these organisms to γ-rays was increased by successive irradiations. The perfectly lethal dosage at the 50th generation was at least 300×10^4 r. Generally in resistant strains, protein hydrolysis and capsule-forming ability were reduced and the virulence of a virulent strain decreased. (auth)

15719 CHANGES IN THE EXCRETION OF SODIUM BY SALIVA AFTER WHOLE-BODY IRRADIATION IN RATS. J. Ondráčkova, M. Raković, and V. Gregora (Charles Univ., Prague). Nature, 197: 915(Mar. 2, 1963).

The effects of whole-body x irradiation on the excretion of Na in the saliva of rats were measured. Possible reaction mechanisms involved are discussed. (C.H.)

15720 VISCOSITY OF SINGLE-STRANDED DEOXYRIBONUCLEIC ACID AFTER X-IRRADIATION IN THE NATIVE STATE. Ulrich Hagen (Universität, Freiburg i. B.). Nature, 197: 1004-5(Mar. 9, 1963).

The effects of x radiation on viscosity of single-stranded desoxyribonucleic acid (DNA) prepared from calf thymus DNA were compared with radiation effects on the viscosity of native thymus DNA. The amount of open hydrogen bonds in the native irradiated DNA was also determined. The viscosity of the single strands decreased by 50% after irradiation with 500 r. Possible factors affecting the high sensitivity of single-strand DNA are discussed. (C.H.)

15721 INCREASED SURVIVAL OF ULTRA-VIOLET-IRRADIATED SHIGELLA SONNEI BY DECREASING THE SURFACE TENSION. Mitsuru Nakamura and Carol M. Ramage (Montana State Univ., Missoula). Nature, 197: 1028-9(Mar. 9, 1963).

A reduction of the surface tension of the suspending medium during the exposure of Shigella sonnei to ultraviolet light resulted in increased survival of the irradiated cells. Possible mechanisms involved are discussed. (C.H.)

15722 THE INFLUENCE OF VERY LOW TEMPERATURES ON THE SENSITIVITY OF THE ASCITES TUMOR TO X IRRADIATION. V. Drášil (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). Neoplasma, 8: 185-93 (1961). (In English)

Ehrlich ascites tumor cells were x irradiated with 1000 to 6000 r at +20, −78, and −192°C and their viability tested by intraperitoneal injection in mice. Survival time of the mice was longer after injection of cells irradiated at −78 and −192° than those irradiated at 20°. The diploid form of the cells was generally more radiosensitive than the tetraploid form. The LD_{50} values at 20, −78, and −192° were 1200, 2100, and 4000 r for diploid cells and 1800, 2900, and 4500 r, respectively, for tetraploid cells. The diminished radiosensitivity of ascites tumor cells at low temperatures may be attributed to the lower reactivity of free radicals, formed by radiolysis of water molecules, with cellular constituents. The results differ from those previously found in

bone marrow cells, whose radiosensitivity was not temperature dependent. (H.H.D.)

15723 THE EFFECTS OF GAMMA IRRADIATION ON LIPIDS OF CHICKEN EGG YOLK. Y. Nonami and Y. Takeuchi (Univ. of Niigata, Japan). Nippon Nogei Kagaku Kaishi, 36: 301-4(1962).

Shell eggs were irradiated with 10^5 and 5×10^5 r. Lipoproteins and free lipids were separated from the yolk by 3 volumes of 1.6% NaCl followed by repeated centrifugation and ether extraction at $-5°$ to $-8°$C. The amounts of the two fractions and the lipid content of the lipoproteins were determined. The acid value, saponification value, iodine value, and unsaponifiable residue of the lipids were examined. It was found that while irradiation has a minor influence on the chemical characteristics of lipids, the yolk lipids in combined form are markedly affected by irradiation. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

15724 INFLUENCE OF X IRRADIATION AND OF ISOLOGOUS AND HOMOLOGOUS RESTORATION ON SPONTANEOUS LEUKEMOGENESIS IN THE AKR STRAIN. J. F. Duplan (Institut du Radium, Paris). Nouvelle Rev. Franc. Hematol., 2: 551-62(July-Aug. 1962).

Studies were conducted on the effect of whole-body irradiation on the incidence and latent period of leukemia in AKR mice. The incidence of lymphoid leukemia in unirradiated mice was 71% in males (latent period 302 days) and 82% in females (265 days). The 70-day-old mice were irradiated with 460, 600, or 800 r, which resulted in mortality rate of 0, 70, and 100%, respectively. Some mice were injected 16 to 20 hr postirradiation with isologous (AKR) or homologous (C_3H and XVII) fetal liver or bone marrow cells. Injection of isologous liver cells did not change the incidence of leukemia, but in the 600-r group it prolonged the latent period. In the 460-r group, irradiation alone did not modify the appearance or incidence of leukemia, and in the survivors of the 600-r group the same negative results were obtained. Isologous bone marrow transplants in the 800-r group significantly reduced the incidence of leukemia (to 21% compared with 75% in controls). A similar reduction was also noted in the 460 and 600-r groups transplanted with homologous marrow cells. A study of the radiochimeras, which resulted, showed that successful transplantation of homologous cells was essential for inhibition of leukemogenesis. It is suggested that the grafted cells of homologous strains are less susceptible or completely insensitive to the leukemogenic virus. (H.H.D.)

15725 EFFECTS OF RADIATION ON THE MOUSE STEM CELL COMPARTMENT IN VIVO. Clifford W. Gurney (Univ. of Chicago and Argonne Cancer Research Hospital, Chicago). Perspectives in Biol. Med., 6: 233-45 (1963).

Different groups of hypertransfused mice were given different doses of whole-body irradiation. All animals received a standard challenge dose of 6 units of erythropoietin within 30 min after irradiation, and this initiated a wave of erythropoiesis, presumably by inducing differentiation of stem cells. The erythropoietic response was determined by measuring the incorporation into newly formed red cells of a tracer dose of radioiron given intravenously 48 hr after irradiation. The impaired erythropoietic response, as measured by the per cent of radioiron tracer, which ultimately appeared in newly formed red cells in the peripheral blood, decreased exponentially with increase in radiation dosage after an initial small shoulder at low doses of irradiation. Possible explanations are given for the early dip. The results tend to substantiate the conclusion that the primary action of erythropoietin is upon the stem cell, inducing differentiation into the red cell series. (P.C.H.)

15726 THE LATE EFFECTS OF RADIATION. Howard J. Curtis (Brookhaven National Lab., Upton, N. Y.). Proc. Am. Phil. Soc., 107: 5-10(Feb. 1963). (BNL-6131)

It is shown that when an animal receives a nonlethal dose of radiation there is an acceleration of the aging process in that animal. A study of this phenomenon led to a dual theory of aging. First, in the normal animal spontaneous mutations accumulate in the somatic cells leading to an inefficiency, malfunction, and finally failure of the organ. Radiations, by increasing the mutation rate, accelerate the process. The second phase involves irreparable damage caused by various stresses, and perhaps normal wear and tear, which weakens the organ and makes it more vulnerable to the deleterious effects of the mutations. Considerable evidence is presented to support this hypothesis. (P.C.H.)

15727 EFFECTS OF IONIZING RADIATION ON A NATURAL PLANT COMMUNITY. J. F. McCormick and R. B. Platt (Vanderbilt Univ., Nashville). Radiation Botany, 2: 161-88(Dec. 1962). (In English)

An island community of spring and summer annuals transplanted from a granite outcrop to the gamma radiation field on the Emory University campus received ionizing radiation along a gradient ranging from 8,000 to 130,000 r at rates of 5–82 r/hr from March to August, 1959. Ecological analyses of experimental and control communities over the subsequent three year period revealed both immediate and long-range effects of ionizing radiation upon individual species and community attributes. Results indicate that ionizing radiation has both stimulatory and inhibitory effects upon plant growth and that the ecological and morphological effects are reflected by species interactions at the community level. Certain post-irradiation changes in the spring flora are interpreted as resulting from a stimulating effect of radiation doses of 8,000 to 30,000 r upon Arenaria brevifolia Nutt. Following irradiation of the parental generation at these levels, the first filial generation of Arenaria was observed to increase in density, distribution, and growth at the expense of a competitive species, Diamorpha cymosa (Nutt.) Britton. These stimulatory effects, apparent only in the first generation, made it possible for this species to continue as the dominant species in the succeeding two generations studied. Other changes in the spring flora resulted from lethal and inhibitory effects of radiation upon plant growth. Changes in the summer flora are interpreted as resulting from the selective elimination of radiation-sensitive species and the subsequent positive selection pressure toward radiation-resistant species. Results of autecological studies indicate that the physiological tolerances of all species usually varied inversely with the level of radiation received. However, under certain conditions, plants which received radiation levels of 8,500 to 25,000 r exhibited environmental tolerances which surpassed those of non-irradiated controls. Whenever physiological stimulatory effects were observed they coincided with similar ecological and morphological stimulatory effects observed in the same species at radiation levels comparable to those used during community analysis. Under all experimental conditions species tolerances varied independently of dose rate. Results of autecological analyses of the post-irradiation tolerances of spring and summer annuals to a variety of environmental stresses correlate with and confirm results obtained from the community analysis. Under all environmental conditions studied, species which became dominant following the irradiation period consistently exhibited greater physiological

tolerances to radiation than did the normally dominant species which they replaced. (auth)

15728 THE ROLE OF THE QUIESCENT CENTRE IN THE RECOVERY OF VICIA FABA ROOTS FROM RADIATION. E. J. Hall, L. G. Lajtha, and F. A. L. Clowes (Churchill Hospital, Oxford). Radiation Botany, 2: 189-94 (Dec. 1962). (In English)

The suggestion that cells in the quiescent center of bean root meristems are relatively insensitive to radiation and promote recovery in irradiated roots is discussed. Experiments indicate that the cells from which root recovery takes place are not protected by anoxia in normal roots; also that the progenies of these cells have the same radiosensitivity as normal meristems. Calculations are presented which show that the number of cells in the meristem surviving irradiation is enough to promote recovery without attributing any special degree of protection to any of the cells; but if recovery can only take place from a small region of the root, the possibility cannot be excluded that cells in this region have reduced radiosensitivity. (auth)

15729 ACTION OF X-RAYS ON CHARA VULGARIS L. III. ROLE OF EUPLOIDY IN THE RESPONSE OF CHARA TO IRRADIATION. C. Gillet (Université, Liège). Radiation Botany, 2: 195-204(Dec. 1962). (In French)

The role of euploidy in survival, growth, and morphogenesis of telomes of Chara vulgaris L., whose apical cells have been x-rayed, was studied by using two chromosomic races (n = 14 and n = 28). Euploids show a higher radioresistance for the phenomena studied except at the 1,560 r doses (the lowest of the doses used). At that dose the rate of growth is higher and ontogenesis less damaged for the 14-chromosome race. This unexpected result is discussed according to the mitotic disturbances observed in the x-rayed material. An interpretation based on the part played by steric factors in the mechanical interactions between normal and altered heterochromatic chromosomes is proposed. So a new factor able to affect the radiosensitivity of plants rich in heterochromatine is put forward. Moreover it is clear that survival curves are modified according to the chromosomes races. Stimulation or suddenly stressed inhibition effects of mitosis are observed in the x-rayed apical cell. These phenomena are delayed in the euploid race and for the same effect require higher doses. (auth)

15730 LOW LEVEL CHRONIC GAMMA IRRADIATION OF A PITCH PINE-OAK FOREST — ITS PHYSIOLOGICAL AND GENETICAL EFFECTS ON SEXUAL REPRODUCTION. F. Mergen and G. R. Stairs (Yale Univ., New Haven and Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 2: 205-16(Dec. 1962). (BNL-6368). (In English)

The effects of chronic ionizing radiation of low intensity (3 to 15 r/20-hr day) over a period of several years on Pinus rigida and Quercus spp. were studied. The examined responses concerned the reproductive capacity of the trees, floral abnormalities, as well as growth of their progenies. For Pinus rigida there was a decrease in cone length that was associated with an increase in the chronic gamma radiation accumulated by the trees. There was also a decrease in seed germination and seedling height for plants grown from irradiated cones: this decrease was related to the total dose accumulated by the individual trees prior to and during seed formation, rather than to the total dose accumulated in the seed. One seed lot accumulated a dose of 3,500 r and had a germination capacity of 96.8% of the control. For Quercus alba there were visual aberrations in flower morphology in trees receiving from 6 to 12 r/day, and internal abnormalities in acorn morphology were present in Quercus alba, Quercus coccinea, and Quercus ilicifolia. Toward the lower levels of radiation the frequency of the abnormalities fell off rapidly and below 4 r/day they were no longer apparent. Quercus alba was the only species showing embryo abortion at approximately 12 r/day. Survival percentage and height growth of seedlings of Quercus alba decreased with radiation level, and significant differences were evident between control seedlings and seedlings from trees receiving 6 r/day. Flower phenology was retarded by 7 to 14 days in both Pinus rigida and Quercus. It was remarked that under certain circumstances a Pinus rigida forest that had been killed by chronic ionizing radiation could regenerate, once radiation had stopped, from seed stored in the cones. These observed effects are discussed in relation to physiological and genetic causes. (auth)

15731 TYPES AND FREQUENCIES OF CHLOROPHYLL MUTATIONS IN DURUM WHEAT INDUCED BY RADIATIONS AND CHEMICALS. F. D'Amato, G. T. Scarascia, L. M. Monti, and A. Bozzini (Università, Pisa, Italy and CNEN, Rome). Radiation Botany, 2: 217-39(Dec. 1962). (In English)

The comparative effects of x rays, thermal neutrons, fast neutrons, diethyl sulfate, and ethyl methanesulfonate were studied, using dry seeds of the cultivated varieties Aziziah, Cappelli, and Russello of durum wheat. Aziziah was found as the most radiation sensitive variety; no statistically significant difference in radiation sensitivity between Cappelli and Russello was ascertained. Excluding the results of two chemical treatments, the three varieties studied did not differ from each other as to frequency and spectrum of chlorophyll mutations in the second generation (M_2). At comparable survival rates, mutation and mutant frequencies in M_2 were two to several times higher after neutron irradiation than after x rays. In the radiation series, maximum rates of chlorophyll mutations were found in treatments producing a 50 to 80 per cent reduction in the mean number of M_2 seedlings per spike; in the most efficient chemical treatments, the reduction in seedling number per spike comprised between 33 and 42 per cent. Chemically induced spectra of chlorophyll mutations were quite distinct from those resulting from irradiation; they were characterized by a reduced frequency of albina and a greater frequency of xantha and viridis. If the distribution of albina, xantha, chlorina, and tigrina was considered in relation to seedling number per spike, it showed a clear accumulation in lower spike fertility classes in the radiation series. In the chemical mutagen series, albina, xantha, and chlorina occurred frequently in spike classes with good fertility, while tigrina typically accumulated in spikes with clearly reduced fertility. Evidence was found that, in chemically treated materials, the mean size of mutated sectors in M_1 spikes is much smaller than following irradiation. It was estimated that, in several M_1 spikes from chemical treatments, four or possibly more initial cells were to be made responsible for the organization of a spike. Evidence is presented that the deficit of recessives shown in M_2 by individuals heterozygous for radiation-induced chlorophyll mutations can be clearly reduced in the transition from M_2 to M_4. Five out of 1024 induced chlorophyll mutations were found to behave as dominant or semi-dominant. (auth)

15732 RADIATION DOSIMETRY FOR Co^{60} AND Cs^{137} GAMMA RAY FIELD IRRADIATION FACILITIES. F. P. Cowan and C. B. Meinhold (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 2: 241-9(Dec. 1962). (BNL-6288). (In English)

Methods for estimating the dose rates to be anticipated from Co^{60} and Cs^{137} field irradiation sources are presented based on the two-medium theory of Berger. A comparison

with experimental values at various distances from several large sources shows reasonable agreement in most cases. A summary of the theory of γ-ray propagation in an infinite medium, a tabulation of dose build-up factors for air, and a discussion of the effect of atmospheric conditions on dose rates are included. (auth)

15733 EFFECTS OF ACUTE GAMMA RADIATION ON GROWTH AND MORPHOLOGY IN PINUS MONOPHYLLA TORR. AND FREM. (PINYON PINE). M. K. Brandenburg, H. L. Mills, W. H. Rickard, and L. M. Shields (New Mexico Highlands Univ., Las Vegas). Radiation Botany, 2: 251-63 (Dec. 1962). (In English)

A Pinus monophylla (pinyon pine) tree was irradiated from a position near the base for eight hours with a Multitron cobalt-60 unit in April, 1960. Shoot apices within fifteen inches (0.38 m, ca. 1300 r to 8000 r) showed almost immediate growth inhibition and were killed within four months. Between two and three feet from the source (0.61 to 0.92 m, ca. 500 r to 200 r) the terminal buds elongated, but by the end of the season had died, and one or two basal lateral buds had developed per shoot. At three to three and one-half feet (0.92 to 1.07 m, ca. 200 r to 150 r) stem elongation proceeded, but the 1961 bud primordia were dwarfed, and lateral buds elongated. Out to four feet (1.22 m, ca. 100 r) no needles developed on the 1960 stem length. From four to five feet from the source (1.22 to 1.53 m, ca. 100 r to 80 r) the number of needles was reduced to from one-half to one-third normal, and approximately one-half were dwarfed. Gnarled growth was common in these dwarf needles. Two vascular tissue anomalies occurred in a number of grossly abnormal as well as in normal appearing needles collected four to six feet from the source (1.2 to 1.8 m; dosages ca. 100 r to below 50 r). One, the double vascular strand probably is related to the naturally occurring fusion process. The other anomaly involved reduction of or lack of vascular tissue. Xylem radii measurements in transverse sections of young stems indicated a decrease in growth for 1960, ranging from 3 to 8 per cent, correlated with increasing exposure. Stem tip elongation in the experimental tree compared with that of the controls was inhibited at doses as low as 15 r. Lateral branching assumes a significant role in shoot recovery from radiation damage, particularly at exposures great enough to affect the actively growing regions of the stem but not the other functional portions. (auth)

15734 CUMULATIVE RADIATION DAMAGE IN OAK TREES. L. W. Mericle, R. P. Mericle, and A. H. Sparrow (Brookhaven National Lab., Upton, N. Y.). Radiation Botany, 2: 265-71(Dec. 1962). (BNL-6374). (In English)

This is a preliminary report of morphological and histological damage in Quercus alba L. and Q. velutina Lam. growing for 10 years (1951 to 1960) in the vicinity of a Co^{60} gamma source. Exposure days per year varied from 111 to 256 and average daily exposure from 0.23 to 13.18 r. During the 10-year period the plants were actually irradiated 20 hrs/day for 2184 days at an average exposure of 7.19 r/day to a total cumulative exposure of about 16,000 r. Gross visible effects include: sparseness of foliage due to death of many lateral or terminal buds or branches; internodes typically reduced in length and increased in thickness; leaves fewer in number, often enlarged, distorted, thickened, and somewhat leathery in appearance; leaves occurring in tufts along otherwise bare branches; abnormal inflorescences. Histological studies revealed: many lateral and terminal buds outwardly appearing viable but lacking meristematic tissue; deterioration of the central pith; reduced number of floral primordia; reduction of viable pollen; lateral meristems apparently not inhibited but rather in some cases unusually active, e.g., cork and lentical formation far exceeding the controls suggesting a stimulation effect. It is suggested that differences in actual absorbed dose and/or rate of cell division may play important roles in the differential sensitivity of apical and lateral meristems. The oaks are found to be much more radiation resistant than trees of Pinus rigida growing in the same area. This difference may be due in large part to differences in chromosome size or interphase nuclear volume. (auth)

15735 METHYL BROMIDE FOR INCREASING I^{131} UPTAKE BY PINE TREES. Frank W. Woods, Mitchell D. Ferrill, and Maxwell L. McCormack (Duke Univ., Durham, N. C.). Radiation Botany, 2: 273-7(Dec. 1962). (In English)

Soil sterilization by methyl bromide greatly increases the uptake by pine trees of I^{131} which had been introduced into the soil. This effect seems to be due to destruction of differentially permeable cytoplasmic membranes of pine roots in treated soil, destruction of soil microorganisms which biologically absorb minerals in the rhizosphere, and prior occupation of the small but significant anion adsorption capacity of soil by bromine compounds. Under these conditions, iodine remains mobile in the soil solution and is swept into the transpiration stream. For other isotopes, soil sterilants with different characteristics might be more effective. (auth)

15736 SUPRAWEAK LUMINESCENCE (450 TO 700 MMK) OF SURVIVING AND HOMOGENIZED NORMAL AND IRRADIATED LIVER TISSUE. A. I. Polivoda and E. N. Sekamova. Radiobiologiya, 2: 801-10(1962). (In Russian)

Dynamics of spontaneous supraweak luminescence (5×10^4 quant/sec cm^3) of tissues was observed during acute radiation sickness. Tissue homogenization as functions of thermal peroxide decay and temperature was analyzed. The concept of an autolytic mechanism in the terminal stages was in agreement with the tissue luminescence. (R.V.J.)

15737 OXIDATION OF THYMINE AND VALINE AND RADIATION INJURY OF PARAMECIA. A. S. Popov. Radiobiologiya, 2: 811-18(1962). (In Russian)

At certain concentrations thymine and hydrogen peroxide mixtures are more toxic to paramecia than hydrogen peroxide alone. Also, the above mixtures and hydrogen peroxide mixtures with valine are more effective in depressing the survived infusoria cell division than H_2O_2. (R.V.J.)

15738 EFFECTS OF EXTERNAL γ RADIATION ON THE ANTIOXIDE ACTIVITY OF THE HEP-2 CULTURE. B. V. Leonov. Radiobiologiya, 2: 819-23(1962). (In Russian)

The antioxide reaction of irradiated tissue cultures to DOPA (β-3.4 dioxyphenyl α-aminopropionic acid) is stronger than the reaction of nonirradiated cultures. Irradiation of the Hep-2 strain to 400 r depresses culture growth to 50% 4 days after the exposure. (R.V.J.)

15739 INFLUENCE OF POST-IRRADIATION CONDITIONS ON γ EFFECTS ON DIPLOID AND HAPLOID YEAST CELLS. V. I. Korogodin and E. M. Karabaev (Inst. of Medical Radiology, Academy of Medical Sciences, Obninsk, USSR and Moscow State Univ.). Radiobiologiya, 2: 824-30 (1962). (In Russian)

Survival and cell growth of γ-irradiated diploid and haploid yeast were studied as functions of nutrient concentration and temperature. (R.V.J.)

15740 RECOVERY OF YEAST CELLS SOON AFTER IRRADIATION. A. Kh. Tambiev (Moscow State Univ.). Radiobiologiya, 2: 831-3(1962). (In Russian)

Dynamics of diploid yeast recovery at various dates after exposure was studied. (R.V.J.)

15741 BLOOD SERUM PROTEINS IN PLUTONIUM INJURED DOGS AND RABBITS. N. I. Elkina. Radiobiologiya, 2: 834-7(1962). (In Russian)

Intravenous injection of nitrate solutions (pH 2) of Pu^{239} into the blood serum of rabbits (7 μC/kg) and dogs (8 μC/kg) reduced the general protein levels, mainly as a result of albumin depression in the blood serum. (R.V.J.)

15742 EFFECTS OF CHRONIC γ IRRADIATION ON HEMOPOIESIS STIMULATED BY LOSS OF BLOOD. A. D. Pushnitsina (Central Scientific-Research Inst. of Medical Radiology, Leningrad). Radiobiologiya, 2: 847-54(1962). (In Russian)

Bone marrow erythropoiesis in chronically irradiated rats depends on dosage and is considerably smaller for low doses. Erythropoiesis injuries stimulated by hemorrhage in rats exposed to low doses are even smaller. The data indicate proliferative processes that seem to be responsible for the restoration of the injured tissues. (R.V.J.)

15743 RADIATION INJURIES OF OVULATION MECHANISM IN FROGS. L. A. Kashchenko (Central Scientific Research Inst. of Medical Radiology, Leningrad). Radiobiologiya, 2: 868-72(1962). (In Russian)

Experiments with semi-mature female frogs, locally irradiated with 18 r and injected with hypophyseal hormones that ordinarily induce ovulation, showed that irradiation either reduced or completely depressed the sensitivity to the gonadotropic hormone and depressed the ovulation ability. Radiation injuries were confined primarily to the follicular epithelium cells. (R.V.J.)

15744 EFFECTS OF CHRONIC Co^{60} IRRADIATION ON HIGH NERVOUS SYSTEM IN WHITE RATS. E. S. Meizerov (Inst. of Biological Physics, Moscow). Radiobiologiya, 2: 878-82(1962). (In Russian)

Chronic daily 22-hour exposures of rats to 6.07r (total 160r) of γ radiation induced serious disturbances of the higher nervous system that were expressed by weakened stimulating and inhibiting processes. The disturbances were of a temporary nature and normalcy was restored after 60 days. Hematological indices revealed no serious general functional disturbances. (R.V.J.)

15745 REPARATION PROCESSES FOLLOWING AN X-RAY EXPOSURE AT ANTENATAL PERIOD. N. A. Kalinina (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 2: 891-6(1962). (In Russian)

X-ray exposure of 11-day pregnant rats depressed the function of the embryonic central nervous system. Six days following the exposure the respiratory functions were weaker and locomotive responses to mechanical skin irritations were depressed. An intensive damage reparation was observed with antenatal development. (R.V.J.)

15746 CYTOLOGICAL ANALYSIS OF INTESTINAL EPITHELIUM IN WHOLE-BODY X IRRADIATION. I. B. Smirnova and I. M. Shapiro (Severtson Inst. of Animal Morphology, Moscow). Radiobiologiya, 2: 897-902(1962). (In Russian)

A quantitative analysis was made of the radiation injuries in white mouse intestinal epithelial mucous membrane induced by whole-body exposure to 400 to 3000 r. (R.V.J.)

15747 EFFECTS OF CERTAIN CHEMICALS ON RADIOSENSITIVITY OF ISOLATED CELLS IN ANIMALS. E. N. Tolkacheva and I. F. Bregadze (Inst. of Biological Physics, Academy of Sciences, USSR). Radiobiologiya, 2: 907-11(1962). (In Russian)

The protective effects of serotonin against radiation damage in Erlich ascitic carcinoma appear only in the presence of oxygen, while AET (β-aminoethylisothiouronium) is effective in the presence of oxygen and under anoxic conditions. (R.V.J.)

15748 EFFECTS OF FAST NEUTRONS ON THE DEVELOPMENT OF WINTER WHEAT. Che'n-man Hsu and V. V. Khvostova (Inst. of Biological Physics, Moscow). Radiobiologiya, 2: 926-30(1962). (In Russian)

Fast neutron irradiation of winter wheat seed to 350, 705 (1959) and 250, 500, 750, and 1000 r (1960) seemed to have no effect on germination; exposures to 1410 and 1760 r slightly reduced germination. However, most seedlings exposed to 1000, 1410, and 1760 r perished during the winter. Generally, neutron exposure depressed seedling growth. Observations in 1960 of some surviving 1959 plants exhibited radiomorphological and hereditary (dominant mutation) changes. Neutron depression of seedling growth in relation to the percentage of chromosome aberrations is about 40-fold higher than in γ exposure. (R.V.J.)

15749 RADIATION EFFECTS ON MORPHOLOGICAL CHANGES IN PLANTS. N. M. Berezina, V. I. Ostapenko, E. I. Korneva, and R. R. Riza-zade (Inst. of Biological Physics, Moscow). Radiobiologiya, 2: 931-7(1962). (In Russian)

Morphological changes in chronically irradiated plants are expressed in supplementary buds. Multiple budding is seen in corn after seed irradiation. Buckwheat, jute, and hemp grow side stems that often are higher than the main stems. Other plants and fruit trees also exhibit branching, leaf doubling, and extra budding. (R.V.J.)

15750 EFFECT OF IRRADIATION ON THE PROTEIN METABOLISM OF ANIMAL TISSUES. Taiji Schimizu, Shin Koyama, Takao Takahashi, and Tomi Morita (Niigata Univ., Japan). Radioisotopes (Tokyo), 11: 293-9(Aug. 1962). (In Japanese)

Liver slices from rats that are x-irradiated with a whole-body dose of 500 r are incubated with C^{14}-labeled glycine, and it is found that the radiation inhibits the glycine incorporation into desoxyribonucleoproteins and soluble protein fractions. Incorporation of T-labeled thymidine into the DNA of actively regenerating liver slices is found to be inhibited. The incorporation of amino acids into microsomal protein in cell-free liver systems is found to be unaffected by x-ray doses up to 5 kr. The PP-ATP exchange with amino acids, promoted by guinea-pig liver enzymes, is not inhibited up to 1 kr of x rays. (T.F.H.)

15751 STUDIES ON HOUSEFLIES, STERILIZED WITH X RAYS. Giuseppe Sacca (Istituto Superiore, Sanità, Rome). Rend. Ist. Super. Sanita, 24: 5-12(1961).

Experiments were conducted on radiosterilization of male houseflies (Musca domestica). The females are monogamous, so that all the females mating with sterile males lay sterile eggs. Tests with 24-kv x rays showed that the most satisfactory method of sterilizing male houseflies consists of irradiating the pupa with 3000 r 2 to 3 days before emergence. The mortality of the irradiated pupae was not appreciably increased and the flies emerging from them were normal in appearance, viability, longevity, and sexual activity. When the irradiated males were mated with normal females, sterility was 100% complete. However, there was a slight tendency for females mated with irradiated males to remate with normal males. Sterile males successfully competed with normal males in search of females, and when they were present in overwhelming numbers succeeded in mating with most of the females, leaving them sterile. (H.H.D.)

15752 THYMUS: ITS ROLE IN LYMPHOID RECOVERY AFTER IRRADIATION. Robert Auerbach (Univ. of Wisconsin, Madison). Science, 139: 1061(Mar. 15, 1963).

Regeneration of spleen lymphoid centers after destruction of lymphoid tissues is dependent on the thymus. (auth)

15753 ON THE QUESTION OF INFLUENCING THE RADIATION SENSITIVITY OF MAMMALS. Hans-Joachim Melching (Universität, Freiburg i. B.). Strahlentherapie, 120: 34-73(Jan. 1963). (In German)

Experimental studies on the possibility of enhancement of radiation resistance in mammals by administration of chemical substances are reported. These studies not only are important for increase of survival rate of the animals, but also yield valuable information on the mechanism of high-energy radiation within the organism. On the basis of the present results it is assumed, that pyridoxal-5-phosphate as coenzyme of the decarboxylase is of special importance for the mechanism of radiation protection and that cystein, contained in the protein component of the enzyme plays a special role as to substrate specificity and specificity of action. The enhancement of radiation resistance in the mammalian organism by administration of biogenic amines as well as of serotonin therefore possibly results from the fact, that decarboxylation of these amines from the appertaining amino acids is deranged by radiation-induced inhibition of the enzyme and coenzyme (pyridoxal-5-phosphate). (auth)

15754 INVESTIGATIONS CONCERNING A BIOLOGICAL RADIATION PROTECTION. REPORT XLVII. ON THE SPECIFICITY OF THE RADIATION INJURY TO THE LYMPHATIC ORGANS. Otfried Messerschmidt, Kyoko Shibata, and Hans-Joachim Melching (Universität, Freiburg i. B.). Strahlentherapie, 120: 74-80(Jan. 1963). (In German)

In previous investigations concerning the influence of splenectomy upon the effectiveness of total body irradiation in mice an increase in survival rate of the animals was observed. A removal of the appendix of the animals before irradiation has no influence upon the survival of the animals. Radiation-induced metabolic changes, such as changes in excretion of taurine in the urine of the animals, can be affected by splenectomy before irradiation, but not by appendectomy. The combination of appendectomy and administration of resistance increasing substances causes an increased resistance by administering AET before appendectomy. It is assumed, that lymphatic tissues and organs have different importances during radiation burden. This is not dependent on the high radiation sensitivity of the total lymphatic system. (auth)

15755 INVESTIGATION OF CALCIUM METABOLISM IN EPI- AND METAPHYSIS AFTER LOCAL X-IRRADIATION. PART V. INFLUENCE OF DENERVATION ON THE GENERAL REACTION. Jaromír Kolář and Arnost Babicky (Univ. of Prague and Biological Inst., Czechoslovak Academy of Sciences, Prague). Strahlentherapie, 120: 98-107(Jan. 1963). (In German)

The course of a generalized metabolic reaction of the total skeleton following local radiation damage was confirmed as reported in other investigations. The influence of the nervous system on the initiating of such a reaction was investigated after denervating the damaged extremity. It was shown that a general reaction does not occur, if the nerve trunks of the damaged extremity were disruptured. It is concluded that the nervous system has an important influence on the general reaction shown by the changes of Ca^{45} metabolism in the skeleton. (auth)

15756 THE PROTECTION OF THE EYE LENS IN TELECOBALT THERAPY. Hans-Joachim Frischbier and Helmut Kuttig (Universität, Heidelberg). Strahlentherapie, 120: 119-22(Jan. 1963). (In German)

The technique for indirect shielding of the eye situated within the irradiation field during telecobalt therapy is reported by using demonstrations of isodoses. The dose at the lens is approximately 10% of the maximum dose measured at electron equilibrium. This dose does not depend upon the arrangement of the shielding within the irradiation area. (auth)

15757 ACUTE GENERALIZED SKIN REACTIONS AFTER X-IRRADIATION — AN APPEARANCE OF RADIOBIOTROPISM. Vladimir Ch. Andreev and Raiko D. Raitchev (Cancer Research Inst., Sofia). Strahlentherapie, 120: 136-43(Jan. 1963). (In German)

Skin disorders similar to acute lupus erythematodes and pemphigus vulgaris were developed in 2 patients, who were irradiated with x rays because of non malignant diseases. The pathogenesis of the skin syndromes is discussed. It is assumed, that they are appearances of radiobiotropism; that means, they are caused by the activation of viruses and other microorganisms during the radiobiological changes in the cells and tissues of the irradiated organism. (auth)

15758 THE USE OF ANTIGENIC TISSUE EXTRACTS TO WEAKEN THE IMMUNOLOGICAL REACTION AGAINST SKIN HOMOGRAFTS IN MICE. P. B. Medawar (National Inst. for Medical Research, London). Transplantation, 1: 21-38(Jan. 1963).

A crude semi-soluble extract of A-strain lymphoid tissues will sensitize C3H mice to A-strain skin grafts when given i.p., but not when given i.v. Intravenous injection of semi-soluble antigen sometimes prolongs the life of homografts. Both its physical form and its route of entry determine whether or not a given antigenic preparation from A-strain mice will sensitize C3H mice. Sensitization is least effective when the i.v. route is used, but antigen in a particulate form will sensitize even when given i.v. and antigen in a soluble form will not sensitize even when given i.p. In the combination C3H → CBA, chosen to typify a weak histocompatibility system, both soluble and particulate antigenic extracts prolong the life of homografts in adult mice when administered in adequate doses through i.v., i.p., or subdermal routes. Antigens administered in such a form or in such a way that they do not excite transplantation immunity may yet excite transplantation tolerance. So administered, antigen acts in synergism with x irradiation, a-methopterin, or hyperimmune isoantibody to prolong the life of homografts more effectively than do any of these agents acting alone. The states of anergy or hypoactivity produced by the concerted action of antigen and immunological depressants must be classified as forms of tolerance or paralysis, not as forms of enhancement. (auth)

15759 DETERMINATION OF SPECIFIC IMMUNOLOGICAL TOLERANCE IN RADIATION CHIMERAS. D. W. van Bekkum (Toegepast Natuurwelenschappelijk Onderzoek, Rijswijk, Netherlands). Transplantation, 1: 39-57(Jan. 1963).

Various hemopoietic cell transfers from mouse radiation chimeras and from normal donors to irradiated recipients were performed, and the reactivity of the spleen cells of the recipients against tissue antigens of both host type and of an unrelated type was followed by means of the graft-versus-host assay in newborn mice. The state of specific tolerance to host-type tissues which is known to occur in certain radiation chimeras was lost on transfer of the tolerant bone marrow to a second host of a different antigenic constitution, and in several combinations specific tolerance towards the new host subsequently developed. This proce-

dure could be repeated with the same line of cells. When tolerant bone marrow or spleen from radiation chimeras was retransferred to irradiated recipients of the original bone marrow donor strain, the tolerance also disappeared rapidly. Only when a large number of lymph node cells was transferred with the bone marrow was a temporary persistence of the specific tolerance observed in the spleen cells of the new host. Attempts to transfer immunity to tissue antigens with bone marrow, spleen and smaller numbers of lymph node cells have thus far failed. It is concluded that memory for the tolerant state is a property of the population of lymphoid cells being transferred and that the expression of this memory is dependent on the relative sizes of the populations. The results emphasize that the antigenic composition of the milieu in which the hemopoietic graft proliferates is one of the most important factors to determine the eventual immunological reactivity of the cell population derived from the donor. Furthermore the possibility is considered that tolerant cells may be at a disadvantage compared to potentially reactive cells as regards the repopulation of a depleted host. The implications of these results for the clinical application of foreign bone marrow transplantation are discussed briefly. (auth)

15760 INDUCTION OF HOMOGRAFT TOLERANCE IN ADULT MICE BY SUBLETHAL X-IRRADIATION AND INJECTION OF HOMOLOGOUS SPLEEN CELLS. A. Fefer and W. C. Davis (Stanford Univ., Palo Alto, Calif.). Transplantation, 1: 75-8(Jan. 1963).

Homograft tolerance was induced in adult DBA/2 mice by sublethal x irradiation and an injection of a suspension of adult BALB/c spleen cells. The optimal conditions for this procedure were determined by varying the dose of x irradiation (200 to 400 r), the time of splenic injection (1 to 72 hours after irradiation), the time of skin grafting (1 to 17 days after irradiation), and the dose of spleen cells (0.01 to 1.0, expressed as a fraction of one spleen). The first 3 factors were found to be of maximal importance. The mortality attributable to the entire procedure was 2%. The procedure failed to induce tolerance across an H-2 barrier. The possible use of this system as a model for studying tolerance induction and maintenance was emphasized. (auth)

15761 THE LOSS OF PARTIAL TOLERANCE FOLLOWING SUB-LETHAL IRRADIATION. W. H. Stone and Ray D. Owen (California Inst. of Tech., Pasadena). Transplantation, 1: 107-15(Jan. 1963).

Rats injected neo-natally for eight weeks with sheep erythrocytes showed partial or complete tolerance when immunized at 13 weeks of age. The degree of suppression was greater for saline than for incomplete agglutinins. Sub-lethal irradiation of the tolerant rats caused a loss of tolerance as measured by the levels of circulating saline agglutinins, incomplete agglutinins, and hemolysins against sheep erythrocytes. There was a definite tendency to lose tolerance spontaneously among the tolerant non-irradiated rats when antibodies were measured as hemolysins, but not when antibodies were measured as saline or incomplete agglutinins. These data are compatible with the hypothesis that the persistence of antigen is necessary for the maintenance of tolerance. (auth)

15762 BIOLOGICAL EFFECTS OF IONIZING RADIATION AT THE MOLECULAR LEVEL. Proceedings of the Symposium Held at Brno, 2-6 July, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Oct. 1962. 471p. (STI/PUB/60). $9.00; 189s; NF 36; DM 31.50(IAEA).

Thirty-nine papers presented at the symposium are given. Separate abstracts were prepared for 37 papers; 2 were previously abstracted for NSA. (A.G.W.)

15763 ROLE OF CHEMICAL COMPOSITION OF BIOLOGICAL MATERIAL ON THE PRODUCTION AND DECAY OF RADIATION-INDUCED FREE RADICALS AND THEIR IDENTIFICATION. B. B. Singh, B. Venkateraman, N. K. Notani, Chandra Mouli, and K. C. Bora (Atomic Energy Establishment, Trombay, India). p.3-13 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

In free radical studies with an ESR (electron spin resonance) spectrometer, dry and moisture-equilibrated maize seeds of 5 strains, two with oil contents differing by a factor of about 20, their hybrid, and two with protein contents in the proportion of 1:4, were treated with over 1×10^6 r of Co^{60} gamma rays and examined continuously for 120 hr after irradiation. It was found that the free radical content of the low oil-bearing seeds was about 50% higher than that of the high oil-bearing seeds immediately after irradiation. The hybrid revealed a more or less intermediate situation. The decay rates showed two components: the first one for about 30 hr following irradiation was fast and exponential in nature and the second, with a level phase extending over the rest of the period, was slow. The hybrid, which was initially intermediate, exhibited a tendency towards the pattern of the high-oil strain about 50 hr after irradiation. The low-protein strain showed about 20% higher free radical content than the high-protein strain immediately following irradiation, but the decay rate of the former was faster than that of the higher strain. This was evident from the fact that after about 30 hr the free radical component of the high-protein strain was about 60% higher than that of the other. This difference was reduced to about 30% after 120 hr. The differences in the free radical contents and the rates of their decay have been attributed to the chemical differences in the seeds. Both low- and high-oil strains exhibited a fine structure in the ESR spectrum. (auth)

15764 TWO KINDS OF ACTION OF IONIZING RADIATION ON DNA. F. Hutchinson (Yale Univ., New Haven). p.15-23 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Three different physical methods can be used to get a "target size" the order of 200,000 molecular weight for the streptomycin-resistant marker in pneumococcus DNA. These three methods are: irradiation in the dry state with x rays; irradiation in dilute solution with x rays, based on earlier results of De Fillipes and Guild on the inactivation of transforming principle and the work of Collyns, Okada, Scholes and Weiss on damage created in the DNA molecule by radiation-produced radicals; and thermal denaturation as described in recently published data by Ginoza and Zimm. However, radiation with particles of high linear energy transfer (LET) gives a target molecule weight of about one million, which is in excellent agreement with the target molecule weight found by Litt et al., for inactivation of transforming DNA with sonication. This apparent discrepancy can by resolved by a simple model in which it is assumed that DNA, in order to transform, must have an intact single strand of molecular weight the order of 200,000. In addition, this piece of 200,000 molecular weight must be included in a piece of molecular weight of one million which essentially has the helical structure intact. This suggests strongly that in general there are two forms of radiation damage to DNA. In one form, damage is done to a single strand only. It is further suggested that this form

of damage can be reversed under the proper conditions, and accounts for the kind of damage which can be altered by varying the oxygen concentration, incubation conditions after irradiation, etc. The other kind of damage is a scission of the double strand. This occurs occasionally with x-ray inactivation, when an unusually high energy release in one strand causes breakage of the adjacent strand also. It is the predominant mode of damage with heavy ions. Thus, an explanation is provided for the fact that damage caused by high LET radiation can rarely be modified effectively. (auth)

15765 DISTRIBUTION IN ENERGY OF THE PRIMARY ENERGY LOSS EVENTS OF ELECTRONS IN CONDENSED MEDIA. A. M. Rauth and F. Hutchinson (Yale Univ., New Haven). p.25-36 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Within the past few years several reasons have appeared for believing that the detailed mechanisms by which charged particles lose energy are different in gases than in liquids or solids. Recently we have measured directly the spectrum in energy of the individual primary events by passing a beam of electrons of energies 5-20 kev through a very thin foil. The energy spectrum of the transmitted beam is then determined by a suitable electrostatic energy analyzer with a resolution of the order of 1 ev. From such measurements, made at a number of different angles to include all the electrons scattered by the foil, it is possible to reconstruct the complete distribution in energy of the energy loss events. Such curves have been obtained for Formvar, polystyrene, carbon, aluminum, aluminum oxide and gold. The energy distribution curves for the first three materials have three important characteristics. Even for very thin foils, very few electrons are found to have lost energy by amounts of between 0 and about 10-12 ev. Secondly, there is a very strong peak in the curve at about 25 ev. Thirdly, the number of electrons which have lost more than 100 ev can be fitted well to the theoretical curve to be expected on the basis of the Rutherford scattering equation. For the first three foils, the mean energy loss per event is of the order of 60 ev. An independent estimate of this number can be obtained by determining the mean free path for an energy loss event in the foil by calculating the fraction of the beam losing energy in the foil as a function of foil thickness. From this mean free path and the known rate of energy loss of an electron beam in the foil, an independent calculation of the mean energy loss per energy loss event can be made. This is, again, about 60 ev for materials of low atomic number. (auth)

15766 USE OF THE ELECTRON PARAMAGNETIC RESONANCE TO OBSERVE RADICALS IN PROTEINS DURING IRRADIATION; ASSOCIATED KINETIC LAWS. A. F. Usatyi and Yu. S. Lazurkii (Kurchatova Inst. of Atomic Physics, Academy of Sciences, USSR). p.37-59 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In Russian)

Free radicals formed in biological polymers during irradiation play an important part in the primary mechanism of radiation damage. It is of particular interest to study the kinetics of their formation, transformation, and disappearance, for which purpose the electron paramagnetic resonance during irradiation must be observed so that changes in the quantity and type of these radicals can be uninterruptedly followed both during and after irradiation. An apparatus was built consisting of a Van de Graaf generator and an EPR spectrometer in order to record the EPR spectra while the sample was being irradiated by electrons with energies up to 900 kev. A brief description of the apparatus and the methods of measurement used are given. The chief characteristics of the equipment are also given; the sensitivity was such that the apparatus could determine a concentration of 5×10^{13} diphenylpicrylhydrazyl radicals; the range of radiation intensity applied in practice was 0.1 to 7.2 Mrad/min and it was possible to make measurements at low and high temperatures, etc. The results of measurements are given for a number of anhydrous proteins: hemoglobin, lisozyme, insulin, salmine and triglycylglycine. In these polymers, as in the synthetic variety, the accumulation of radicals on irradiation as a function of time follows a curve which reaches saturation. As a general rule, the level of saturation increases with the radiation intensity, tending towards a certain limit ("complete saturation"). When irradiation is stopped the number of radicals decreases. In certain conditions (vacuum, low temperatures) and also in the case of some proteins and in air at room temperature, the rate at which the number of radicals decreases can be very slow. Saturation is observed during irradiation, as described above, but its level does not depend on the intensity of the radiation. Saturation is thus brought about by the disappearance of radicals resulting from the effects of the radiation itself; besides forming new radicals, radiation leads to the disappearance of those already present. The following kinetic equation expresses the experimental results: $dN/dt = \alpha j - \gamma Ni - \beta N$, where N = the number of radicals, j = radiation intensity and α, β, and γ are constants. In some cases the term $\Sigma_i \beta_i N_i$ can take the place of βN, i varying between 1 and 4. When the number of radicals does not fall after irradiation, $\beta = 0$. The term γNj characterizes the decrease in the number of radicals consequent upon irradiation. The mechanisms which may be responsible for this process are discussed. An accelerated rate of recombination among radicals, or the interaction of radicals with gases resulting from the increased rate of diffusion during irradiation, may be one mechanism. A first-order kinetic reaction can be observed while recombination is proceeding, and there is a fairly high probability of recombination if the radicals are formed pair-wise in various molecules at relatively short distances from each other (as was assumed in other cases, e.g., polyethylene). Another possible mechanism is the destruction of a radical (or its conversion to an ion-radical) when a particular molecule is re-ionized as a result of the intermolecular migration of an electron (leaving "holes") with an accompanying change in excitation value or charge. The objections to the first hypothesis are discussed, as are methods of experimentally checking the assumptions made with respect to both mechanisms. Attention is drawn to the importance of investigating the dependence of kinetic coefficients on the length of the polypeptide chain and on temperature. (auth)

15767 EFFICIENCY OF RADICAL PRODUCTION BY X-RAYS IN SUBSTANCES OF BIOLOGICAL IMPORTANCE. A. Mueller (Kernforschungszentrum, Karlsruhe, Ger.). p.61-72 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Radical concentrations per unit energy of absorbed ionizing radiation in dry amino acids, proteins, and nucleic acids determined in several laboratories are compared and discussed. Measurements in our laboratory were performed using a newly developed method incorporating a double-sample cavity and a momentum balance. The measured radical yields agree satisfactorily with several other de-

terminations but are at variance with some earlier measurements. Possible explanations are given for these divergencies. An interesting result of our measurements is the small spread and low absolute value of the radical yields, with the exception of amino acids containing aromatic rings. Approximately one radical is produced per 100 ev of absorbed energy (or roughly one radical per primary ionization). Radical yields in gelatine were measured at various temperatures following irradiation in vacuo at 77°K and 300°K. After warming a sample to 300°K within a few minutes following irradiation in vacuo at 77°K the radical yield found was three times lower than the radical yield observed after irradiating at room temperature. The enhanced yield is not only quenched at low temperature irradiation in vacuo but also at high temperature irradiation in the presence of air. The admission of oxygen or lowering the temperature after irradiation does not diminish the radical yield. The reaction leading to the high yield is much faster than other radical reactions reported previously. (auth)

15768 THE RADIATION CHEMISTRY OF ORGANIC LIQUID MIXTURES. J. F. Merklin and S. Lipsky (Univ. of Minnesota, Minneapolis). p.73-90 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Studies have been made of hydrogen yields produced by gamma irradiation of mixtures of cyclohexane-benzene, cyclohexane-phenylcyclohexane, methylcyclohexane-benzene, methylcyclohexane-benzylcyclohexane, phenylcyclohexane-benzene, and benzylcyclohexane-benzene. For the cyclohexane and methylcyclohexane mixtures measurements were made over a 10^5-fold variation in aromatic concentration. Effects specific to aromatic concentration below 10^{-2}M have been found. In the higher concentration region particular attention has been given to comparing the relative efficiencies of benzene, phenylcyclohexane and benzylcyclohexane in reducing hydrogen yields from cyclohexane and methylcyclohexane. In addition a comparison has been made of the radiation stabilities of phenylcyclohexane and benzylcyclohexane with the stabilities of physical mixtures of cyclohexane-benzene and methylcyclohexane-benzene respectively. Energy transfer mechanisms, in weak and strong coupling approximation, are briefly reviewed. (auth)

15769 PROPORTION OF THE DIRECT AND INDIRECT EFFECT OF RADIATION IN RADIATION DAMAGE OF SOME ANIMAL CELLS. V. Drášil (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). p.91-7 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Bone-marrow cells and Ehrlich ascites tumor cells were irradiated at different temperatures in vitro. Very low temperatures (−78 and −192°C) afforded good protection to the ascites cells, whereas the bone-marrow cells were protected only slightly under the same conditions. From these results it can be concluded that the direct effect of radiation predominates in radiation damage to the bone-marrow cells. In a further series of experiments the influence of some protective substances and anoxia on the radiation sensitivity of ascites cells was tested. It was shown that AET, cysteine, thiourea and thiosulphate gave good protection against x radiation at +20°C. But if the cells are irradiated at −78°C, the protective effect of low temperatures is markedly increased only by cysteine and AET. On the basis of these experiments it seems that in radiation damage to ascites tumor cells the effect of radicals and peroxides plays a considerable part at normal temperatures. Cysteine and AET protect against both direct and indirect effects of radiation when irradiated at temperatures above freezing point. If the irradiation is carried out at very low temperatures cysteine and AET protect against the direct effect of radiation. Thiourea and thiosulphate are evidently incapable of protection against the direct effect of radiation, as they are effective at normal temperatures only. (auth)

15770 CHANGES IN THE COMPOSITION OF WATER-SOLUBLE HEPATIC AND BLOOD-SERUM PROTEINS IN THE EARLY STAGES OF RADIATION SICKNESS. E. M. Belyaeva. p.101-8 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In Russian)

With a view to explaining the mechanism of radiation sickness it is of great importance to study the changes which occur in tissue proteins when the organism is exposed to ionizing radiation and to explain the microlocalization of these changes in individual sub-microscopic structures of the cell. The research was carried out by electrophoresis (on paper and in agar) of total water-soluble hepatic proteins and the proteins for individual cell components (mitochondria, microsomes, and hyaloplasm) after x and gamma irradiation of rats and rabbits at lethal doses. It was found that the proportion of those hepatic proteins which correspond, in terms of mobility, to beta-globulin already shows a decrease in the period from two to six hours after irradiation—principally as a result of the lower level of such proteins in the mitochondria, and to a lesser extent in the mocrosomes—while the number of proteins with the mobility of alpha-globulin increases, largely owing to the increased proportion of such proteins in the mitochondria, and also in the hyaloplasm. Exposure of proteins to penetrating radiation results in modification of their immonological characteristics. By using Ouchterlony's method for specific precipitation in gel the author found that there was incomplete immunological identity of hepatic proteins in healthy and irradiated animals, and a change in the antigen spectrum of proteins which had been exposed to radiation. Electrophoretic examination of the blood-serum proteins of rabbits irradiated at 800 r showed that it takes only two hours for the beta-globulin fraction to disappear—and this at a time when there is a quantitative increase in the globulin fractions. With the peracute form of radiation sickness (with massive irradiation at a total dose of 30,000 r) the author found irreversible changes in the fractional composition of blood-serum proteins within ten minutes of initial exposure. The changes are analogous to that found in the normal form of radiation sickness. (auth)

15771 EFFECTS OF IONIZING RADIATIONS ON NUCLEIC ACIDS AND NUCLEOPROTEINS. G. Scholes and J. J. Weiss (Univ. of Durham, Newcastle Upon Tyne, Eng.). p.127-36 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

When aqueous solutions of deoxyribonucleic acid (DNA) are irradiated with ionizing radiations, degradation and denaturation processes occur, these being the result of reactions of the active species produced by the radiolytic decomposition of water. The nature of these changes is discussed. Irradiation of aqueous systems of calf thymus nucleoprotein, in the presence of oxygen, has shown that, in the intact nucleoprotein, the radicals react preferentially with the protein; in 0.02–0.03% solutions irradiated with doses up to $\sim 2.5 \times 10^5$ rad the protein gives a minimum of 90% protection from attack on the DNA component. (auth)

15772 SOLID STATE PROCESSES IN SERUM ALBUMIN IRRADIATED AT LOW TEMPERATURES. S. O. Nielsen and B. V. Rasmussen (Danish Atomic Energy Commission Research Establishment, Risø, Denmark). p.137-48 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

In order to further characterize the migration of energy in proteins following their exposure to ionizing radiation, dried crystallized bovine serum albumin in lyophilized form was sealed in special evacuated ampoules and irradiated with low doses (1.0–1.5 Mrad) of 10 Mev electrons from a linear accelerator at fixed temperatures between −196 and 43°C. After irradiation the ampoules were kept in liquid nitrogen and the protein collected in the annealed tip of the ampoule that could later be placed in a Varian 100 kc/s modulated electron spin resonance (ESR) spectrometer equipped with a quartz Dewar in the cavity for measurements at −196°C. Similar irradiations and ESR measurements were also performed on performic acid-oxidized serum albumin and on poly-L-alanine. The results are still not complete but seem to indicate: (1) that the number of radicals produced in lyophilized serum albumin per 100 ev of radiation absorbed at temperature $T°K(G_T)$ varies so that $G_{316} > G_{77} > G_{195} > G_{273}$; (2) that the migration of the unpaired electrons in lyophilized serum albumin to the cystine residues, on warming the protein irradiated at 77 to 323°K, is only about 50% efficient, the other half of the electrons being lost; and (3) that performic acid-oxidized serum albumin gives a slightly higher G_{77} value than native serum albumin. The G_{77} value for poly-L-alanine in its β-form is almost the same as for performic acid-oxidized serum albumin. These and other results obtained are discussed in relation to some possible solid-state processes in irradiated serum albumin. (auth)

15773 ELECTRON SPIN RESONANCE AND FREE RADICALS INDUCED IN DEOXYRIBONUCLEIC ACID BY GAMMA RADIATION. Jules Duchesne (Université, Liege). p.149-60 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In French)

Electron spin resonance is used to study the effects produced by Co^{60} gamma radiation in DNA in the solid phase. By varying the dose rate as well as the dose it is possible to modify the free radical production and the post effects to an extent depending on the nature of the atmosphere surrounding the sample during irradiation. It is also suggested that the magnetic radio-resistance of DNA depends on its molecular weight. (auth)

15774 X-IRRADIATION OF GLUCOSE OXIDASE (NOTATIN) AND RIBOFLAVIN. H. W. Laser (Cambridge Univ., Eng.). p.161-74 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

The theorem that ionizing radiation is generally more effective when applied in the presence of oxygen than under anaerobic conditions is not without important exceptions. Thus catalase has been found to lack an oxygen effect, which is also absent with bacteriophage and transforming principle. The present work deals with the effect of x irradiation on the flavo-protein glucose oxidase (notatin) and on riboflavin. The effect on the enzyme was evaluated by determining its catalytic activity in the oxidation of glucose, that on riboflavin by spectrophotometric measurement of reversible or irreversible oxidation or reduction. The main results with notatin are: increasing inactivation with increasing dilution, that is, indirect effect; reversal of the oxygen effect, that is, destruction of the enzyme is greater on anaerobic than on aerobic irradiation; sensitization of the enzyme, that is, increased destruction, on aerobic irradiation in the presence of its specific substrate, glucose; protection of the enzyme on anaerobic irradiation by the addition of glucose as well as some unspecific substrates, also on the addition of proteins. The latter, however, do not abolish sensitization by glucose during aerobic irradiation. These facts point to the importance of the state of oxide-reduction of the flavin in determining radiosensitivity and made further examination desirable. As it was not practicable to isolate large enough amounts of the (flavin) prosthetic group from notatin or from an amino-acid oxidase, riboflavin was chosen as a related model. The flavin being highly autoxidizable, a method was devised by which it could be reduced, irradiated, and its spectrum measured throughout under hydrogen gas before finally determining the remaining autoxidizable, that is the intact, fraction. The main results were: irreversible destruction of oxidized flavin on aerobic irradiation; and to a large extent reversible reduction (of the oxidized form) and reversible oxidation (of the reduced form) on anaerobic irradiation. This is believed to be probably the first demonstration of reversible irradiation effects, which may ultimately contribute to establishing the basis of the oxygen effect in a manner potentially at variance with some of the currently propagated or accepted theories. (auth)

15775 EFFECT OF X-RAYS ON THE TRANSLOCATION OF LABELLED NUCLEIC ACIDS AND PROTEINS IN GERMINATING BARLEY. L. Ledoux (Centre d'Études de l'Énergie Nucléaire, Mol, Belg.). p.175-82 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Different macromolecules have been prepared and labelled with H^3 or C^{14} by biological synthesis. These molecules have been used to study the permeability of various vegetal or animal organs, tissues, or cells. With germinating barley, for instance, it has been shown that intact ribonucleic acid can be transferred from the seed to different organs. The same is also true for various proteins: ovalbumin, conalbumin, lysozyme, ovomucoide, ribonuclease, and for deoxyribonucleic acid. In this case, a paper chromatography method on diethylamino-ethyl (DEAE) cellulose was used to follow the fate of the migrating macromolecules of DNA. The influence of x rays on the translocation phenomena has been studied at different dose levels. Irradiation rapidly inhibits the translocation at low doses (500 r) and sometimes suppresses it at higher doses (from 3000 r). In that respect, however, the translocation of the various macromolecules is differently affected by x rays. There seems to be no relation to the molecular weight nor to the isoelectric point of the migrating substances. A comparison of these results with those measuring the influence of x rays on the RNA, DNA, and protein metabolisms in the barley organs shows that the translocation mechanisms are in general more radiosensitive than the synthetic processes. As the translocation phenomena seem to be quantitatively very important in barley embryos (for instance the amount of exogenous RNA which can be transferred accounts for 90% of the new RNA found in the organs), the effects of irradiation on the translocation phenomena might be of some importance for the fate of some parts of the embryo. (auth)

15776 MODIFICATION OF BETA-INDOLACETIC ACID BY IONIZING RADIATIONS. T. Cervigni and M. L. Belli

(Comitato Nazionale per l'Energia Nucleare, Rome). p.193-202 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In Italian)

The action of ionizing radiations (x rays and gamma rays) on aqueous solutions of beta-indolacetic acid (AIA), which might partially explain the effect of radiation on plant growth, has up to now not been clarified. According to the experiments of Skoog, the AIA molecule is very sensitive to low doses of radiation whereas, according to the more recent experiments of Gordon and Weber, it is much more resistant. A re-examination of the technique of measuring the portion of the AIA not modified by radiation (separated by paper chromatography) has produced results very close to those of Skoog. In the opinion of the authors this chromatographic technique is the only possible one for proving the chemical identity of the product. The absorption spectrum of the mixture might not be modified if the pyrrole ring was intact; similarly, the molecules conserving the indole ring could interfere with the Salkowski colored reaction. In the biological reaction, too, there could be interference with the substances of similar biological activity formed after irradiation. The modifications of the AIA as a function of dose depend upon its concentration in the solutions. For the highest concentrations, there is no modification of the uv spectrum of the irradiated solution, even with doses of 10,000 r. For concentrations less than 5.3×10^{-5} M, radiation (even as low a dose as 100 r) profoundly alters the maxima at 220, 282, 290 μm and the minimum at 245 μm. (auth)

15777 STRUCTURAL CHANGES OF NUCLEIC ACIDS SYNTHESIZED IN SALMONELLA TYPHIMURIUM AFTER UV IRRADIATION. T. A. Hudnik-Plevnik, M. M. Simić, and D. T. Kanazir (Boris Kidric Inst. of Nuclear Sciences, Belgrade). p.203-10 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

It was shown in earlier publications that deoxyribonucleic acid (DNA) synthesized in Salmonella typhimurium after a 50% lethal dose of uv light differs from normal DNA in respect to its physical-chemical and chemical properties. It is shown in the present paper that the alterations observed on DNA after uv irradiation of Salmonella typhimurium are to some degree dose-dependent but are not detectable in the absence of DNA synthesis. It seems, therefore, that the expression of the damage produced on DNA during irradiation becomes detectable by chemical means only if replication of DNA after irradiation has been taking place. All the analyses employed (thermal denaturation followed spectrophotometrically, hyperchromic shift after acidification, and base ratio determination) suggest that DNA synthesized after irradiation contains less thymine and more cytosine and guanine than the normal one. It will be reported also if similar alterations can be found on ribonucleic acid synthesized in bacteria after uv irradiation. The structural changes in nucleic acids found in Salmonella typhimurium after uv irradiation may offer an explanation for the secondary death and the inability of the bacteria to synthesize adaptive enzymes after exposure to uv light. These qualitative alterations of nucleic acids of the irradiated bacteria take place in spite of the fact that their synthesis is practically unaltered and are reflected in changes of their biological functions. (auth)

15778 THE EFFECT OF γ-RADIATION ON AQUEOUS SOLUTIONS OF β-LACTOGLOBULIN IN THE PRESENCE AND ABSENCE OF OXYGEN. G. Glew and P. I. Hansen (Wantage Research Lab., Berks, Eng.). p.211-20 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Aqueous solutions of β-lactoglobulin were irradiated in the presence and absence of oxygen with Co^{60} γ rays. In the absence of oxygen little change in the pH was observed after irradiation within the dose range 0 to 7.5 Mrad, whereas, when oxygen was present the pH fell from 7.8 to 5.0 in the same dose range. Also the SH and S-S concentration decreased rapidly as the dose increased from 0.5 to 7.5 Mrad in the presence of oxygen with the possible formation of acidic oxidation products of sulphur. These sulphur-containing groups were more resistant to radiation when oxygen was absent. At dose levels below 0.6 Mrad when oxygen was present the disappearance of SH groups was accompanied by an increase in the disulphide concentration; whilst in the absence of oxygen there was little change in the SH and S-S titre. At higher doses general degradation of sulphur-containing groups appears to take place, whereas at low doses in the presence of oxygen some SH groups may be oxidized to S-S linkages. Increases in viscosity which were observed at doses below 2 Mrad may be due to unfolding of the molecule but the formation of intermolecular S-S linkages may play a minor part. At dose levels higher than 2 Mrad the viscosity continued to increase when oxygen was absent, which suggests that cross-linking takes place, but in the presence of oxygen the viscosity decreased, possibly indicating chain scission. (auth)

15779 THE INFLUENCE OF INORGANIC PEROXIDES ON THE RADIOCHEMICAL TRANSFORMATIONS OF PURINES AND PYRIMIDINES IN AQUEOUS SOLUTIONS. M. I. Amiragova, A. V. Savich, and M. I. Shal'nov. p.221-5 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In Russian)

Ultraviolet spectrophotometry was used to determine the radiochemical decomposition yield of guanine, uracil, and orotic acid in dilute aqueous solutions (concentrations from 10^{-5} to 10^{-2} M) and aqueous solutions containing admixtures of inorganic peroxides—hydrogen peroxide and sodium persulphate. It was found that for low concentrations of purines and pyrimidines (from 10^{-5} to 5×10^{-4} M) the addition of inorganic peroxides results in an increase in decomposition yield, the maximum yield being obtained at a concentration of about 3×10^{-6} M, which is approximately the same as the concentration of free nucleotides in the cell. Of the substances studied, the most radiosensitive in the presence of peroxides is orotic acid, which is an important intermediate product in the biosynthesis of nucleic acids. The action mechanism of inorganic peroxide additions to the systems dealt with and the part played in radiobiological processes by damage to the free purines and pyrimidines in the cell are discussed. (auth)

15780 THE POSSIBLE NATURE OF PHYSICAL MECHANISMS IN ENZYME INACTIVATION AS DEDUCED FROM TEMPERATURE STUDIES. L. G. Augenstein and R. Mason (Michigan State Univ., East Lansing). p.227-38 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

The data relating to the temperature dependence of the inactivation of enzymes and other biological systems by ionizing and uv radiation are critically reviewed. From the usual Arrhenius plots of the logarithm of radiation yield versus 1/T, it seems clear that the effects of temperature can be resolved into two components. Below about 250°K, radiation sensitivity is essentially temperature-independent,

whereas at higher temperatures an activation energy of 2.2 kcal/mole is associated with enzyme inactivation. From the available data it appears that this behavior is characteristic of the effects of both ionizing and uv radiations, although the estimates of the relative number of temperature-dependent and -independent events vary considerably with differences in LET. There is both theoretical and experimental evidence that the commonly accepted one-ionization model is inadequate to completely explain enzyme inactivation. In particular, on the basis of the present analysis, the possibility is considered that the inactivation yields from sub-ionizing electronic excitations greatly exceed those from ionizing events. In these considerations it is tentatively concluded that the initiation of charge migration processes associated with such excitations is the temperature-dependent step which is rate limiting. The implications of these conclusions to radiobiological mechanisms in general are briefly considered. (auth)

15781 THE EFFECT OF IONIZING RADIATION ON PROTEIN METABOLISM IN THE CENTRAL NERVOUS SYSTEM AND THE LIVER. L. S. Cherkasova and K. V. Fomichenko. p.241-53 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In Russian)

Proteins play a fundamental role in the vital functions of living organisms. Nevertheless, our knowledge of the biochemical damage caused by radiation in protein structures–complex proteins, enzyme proteins, and hormones in animal and human organisms–is still highly inadequate and often contradictory. This is particularly true of changes in protein metabolism in the central nervous system, the condition of which determines to a large extent the further course and development of radiation damage. Nor is there adequate information available about the influence of the more remote consequences of fractionated, oft-repeated irradiation on protein metabolism. The purpose of this research was to study the effect of the total fractionated dose of x rays on the protein content of various parts of the central nervous system (the cerebral hemispheres, cerebellum, and spinal cord) and of the liver which, so far as proteins are concerned, has important metabolic functions. The experimental animals were half-grown white rats weighing between 170 g and 200 g. These were irradiated by a RUM-3 apparatus, without filter, at 165 kv, current 5 ma; source–skin distance 40 cm; dose rate (air) 21 r/min; total irradiation 760 r, administered in single 40-r doses over a period of one month. The animals developed chronic radiation sickness. They were examined at 15, 30, 60 and 90 days after irradiation. Changes in the various protein fractions were studied, the method of Polister and Mirsky being used to isolate the fractions; in a number of cases the dissolved liver proteins were separated by electrophoresis. By the first method, the following fractions were studied: fraction A, extracted with 0.14 M NaCl and containing mainly cytoplasmic ribonucleic proteins; fraction B, extracted with 1 N NaCl and consisting chiefly of the nuclear deoxyribonucleic proteins; fraction C, proteins soluble in 1 N NaOH and consisting of the neurostroma normally found in nerve tissue; and fraction D, consisting of a residue of amino acids, insoluble in alkalis and containing carrier proteins, neurokeratins for nerve tissue and the water-soluble fraction. Seven fractions of soluble liver proteins were obtained by electrophoresis. Fractionated x irradiation produced phased changes in the amounts of all the protein fractions studied. In all sectors of the central nervous system the amount of fraction A proteins had increased at 15 and 60 days after irradiation, while at 15 and 90 days the content of fraction B proteins had unmistakably dropped. The amount of fraction C and D proteins fluctuated, but it was considerably reduced three months after irradiation, the amount of amino acids being unstable. Changes and disturbances were even more pronounced in the protein content of the liver. Fraction A proteins rose, whereas fraction B proteins and amino acids dropped considerably; three months after irradiation, carrier proteins were down by as much as 35% as compared with the controls. By separating the fractions by electrophoresis, the ratios between the various liver-protein fractions at each stage following fractionated x irradiation were determined. (auth)

15782 PYRIMIDINE PRECURSORS OF DNA IN CELLS AND THEIR POSSIBLE ROLE FOR DNA SYNTHESIS AFTER IRRADIATION. L. Beneš and J. Soška (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). p.255-62 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

In previous publications a favorable effect by pyrimidine precursors of DNA on post-irradiation disturbances in mice was reported. In further experiments studies were made on the level of free precursors of DNA in tissues and cells and the effect of these substances on DNA synthesis in individual bone-marrow cells. In the spleen and other tissues the content of free deoxyribosides and deoxyribotides rose sharply a few hours after irradiation. However, this rise was followed by a drop below the initial level. In the liver of partially-hepatectomized rats a rise in deoxyribosyl compounds, especially of deoxycytidylic and thymidylic acids, could be established while irradiation produced complete or partial inhibition of this rise. The effect of deoxynucleotides and deoxynucleosides on DNA synthesis was tested in individual bone-marrow cells in vitro and the effect of the given compounds was compared. The application of pyrimidine derivatives led to an increase of DNA synthesis in recticular cells, while no significant effect of purine compounds could be found. In experiments in vivo the number of DNA synthesizing cells was followed in the time course after irradiation. It was found that in the period of maximum accumulation of free deoxyribonucleosidic compounds the number of DNA-synthesizing reticular cells rose transiently, even though the number of synthesizing cells of other types had fallen. The results are discussed from the standpoint of radiation on the inhibition of DNA synthesis. (auth)

15783 ON THE NATURE OF ENZYME INACTIVATION BY RADIATION. L. G. Augenstein (Michigan State Univ., East Lansing) and K. L. Grist. p.263-76 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (BNL-6239). (In English)

The "one-ionization" model can usually explain data on enzyme inactivation by ionizing radiation so long as irradiation is at room temperature, the enzyme preparations are very pure, and effects resulting from water radicals are excluded. However, in many situations the "radiation cross-sections" derived from this model are much larger than the feasible dimensions of the enzyme molecules. Both experimental and theoretical evidence now indicate that two premises of the one-ionization model are incorrect. Consideration of the Bethe formula and recent extensions of excitation theory show that studies of the distributions of ions in fairly pure gases does not indicate all the factors

pertaining to radiobiological effects in biological preparations. In such condensed systems of quite heterogeneous atomic composition the fact that the excitation of molecules by electron impact depends upon the oscillator strengths for electromagnetic absorption means that the distribution of excitation events is not at all random. In this regard proteins have relatively strong absorption bands in the region 4–10 ev. Thus, under many conditions such subionizing excitations can contribute significantly to inactivation, even though the probability that any given excitation will produce inactivation is small. An important mechanism for enzyme inactivation by ~5-ev excitations is the disruption of specific S-S and hydrogen bonds. That is, the destruction of trypsin and ribonuclease activity is directly correlated with an increase in the number of titrable –SH groups and impediments on the ability of the products of disrupted S-S and/or hydrogen bonds to reform and increases the measured inactivation yields. However, not all S-S bonds are equally susceptible to radiation disruption. In particular, when ribonuclease samples are irradiated sufficiently to destroy up to 75% of enzymic activity, the increased –SH groups which can be titered arise almost exclusively from only two of the constituent eight half-cystines. Such preferential localization of radiation effects is consistent with earlier postulates (of LGA) concerning the mechanism of enzyme inactivation by a number of physical agents. (auth)

15784 β-AMINO-ISOBUTYRIC ACID AND TAURINE EXCRETION, AND PLASMA LEVELS AFTER LOCAL X-RAY IRRADIATION, IN TWO CANCER PATIENTS. E. J. Bigwood and P. Soupart (Université Libre, Brussels). p.277-86 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Hyperaminoaciduria was observed in subjects accidentally injured by nuclear radiations, by Hempelmann et al. and Jammet et al. The question whether therapeutic x-ray treatment of cancerous patients produces similar effects was studied. Spackman, Moore, and Stein's completely automatic method of ion exchange chromatography was used before and after treatment. One of the subjects suffered from chronic lymphocytic leukemia; at first he received in the spleen area a 50-r x-ray external dose, followed after a few days by similar exposures, alternatively on the spleen area and on lymph nodes in the neck. Complete chromatograms of free amino acids in urine (24 hr output) and of free amino acid levels in blood plasma were obtained. They showed normal profiles before treatment. The two main features consisted in a ten-fold increase in taurine excretion and a four-fold increase in β-aminoisobutyric acid excretion, within the first 24 hr following the first dose of x rays. Both free and combined taurine were increased to that extent; during the following days, the excretion regressed, but stayed high, and the subsequent x-ray doses did not produce a significant new rise in output of both amino acids. In plasma, the level of taurine was significantly increased. All the other free amino acids were unaffected, except perhaps for an increase in methionine sulphoxide. The origin of the two main features concerning the two above-mentioned amino acids is discussed. It is most probably different in each of the two cases. The second patient, in which quite similar plasma findings were observed, suffered from Hodgkin's disease. The above-described phenomenon was examined, in this latter case, in conjunction with serum transaminase activities taken as an index of cell injury. (auth)

15785 EFFECTS OF TOTAL-BODY X-IRRADIATION ON AN INHIBITOR OF THE DNA SYNTHESIZING ENZYMES OF REGENERATING RAT LIVER. R. Goutier and I. Bologna (Centre d'Études de l'Énergie Nucléaire, Mol, Belg.). p.287-91 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Gray et al. observed that aqueous extracts of normal liver inhibit in vitro the thymidylic kinase and DNA polymerase of extracts of proliferating tissues (regenerating liver, bone-marrow cells, ascites tumour cells). Using the technique of Bollum, we observed that the incorporation of H^3-thymidine into DNA at pH 8.0, catalyzed in vitro by extracts of regenerating liver, was inhibited by about 30% by aqueous extracts of normal rat liver. By extracts is meant the supernatant fraction of a homogenate after 50 min centrifugation at 300,000 g. Extracts of normal rat liver in isotonic sucrose, however, do not inhibit the in vitro incorporation. Normal rat liver homogenates were fractionated in sucrose 0.44 M. The nuclear, mitochondrial, and microsomal fractions were tested in vitro for their ability to inhibit the kinase and polymerase activities of extracts of regenerating liver. Only the microsomes produced a marked inhibition (50 to 80%) of the incorporation in vitro. Ribosomes do not inhibit. The addition of 1 mg RNA does not depress incorporation. Microsomes prepared from regenerating rat liver display a significantly reduced inhibitory action: when the rats receive 1000 r total-body x irradiation just before hepatectomy, the reduction of the inhibitory power of the microsomes, observed during normal regeneration, is much less pronounced. The inhibition reaches about 40% after 24-hr regeneration in irradiated rats, against 25% in non-irradiated animals and about 60% in non-irradiated, non-regenerating livers. After 42-hr regeneration, the inhibition by microsomes is only 10 to 20% in non-irradiated rats and about 40–50% in irradiated animals. The effect of chemical radio protectors injected before or after irradiation is under investigation. (auth)

15786 SENSITIZATION OF BLOOD RED CELLS TO X-RAYS BY MONOIODOACETIC ACID. M. Quintiliani, E. Strom, M. Bianchi, and M. Boccacci (Istituto Superiore di Sanita, Rome). p.295-306 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

The effects of x rays and of monoiodoacetic acid on the permeability of the membrane of rabbit erythrocytes were studied in vitro. The following tests were performed: potassium loss and hemolysis and increase of aldolase activity detectable in an isotonic incubation medium. The red cell membrane is slightly permeable to the aldolase substrate so that the enzymatic activity measurable in control suspensions is very low. It is confirmed that irradiated red cells lose potassium and hemolyse in relation to the dose of x rays. The loss of potassium is about four times more sensitive than hemolysis. In irradiated red cells the detectable aldolase activity increases equally in relation to the dose of x rays. This effect appears to be related to impairment of the cell membrane which becomes permeable to the fructose diphosphate. The pre-incubation of red cells with monoiodoacetic acid in concentrations which do not affect any of the responses which have been examined induces an increase in the effects of radiation in all cases. The effects of x rays in erythrocytes pre-treated with monoiodoacetic acid correspond at least to the effects obtained with more than double the dose of radiation in

erythrocytes irradiated alone. No increase in the effects of radiation has been observed when the red cells were treated with monoiodoacetic acid immediately after irradiation, or when they were washed (after incubation with monoiodoacetic acid) prior to irradiation. (auth)

15787 OBSERVATIONS ON THE IRRADIATED RED CELL MEMBRANE. R. Brinkman (Univ. of Groningen, Netherlands). p.307-14 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

An attempt to use the red cell envelope as a model for radiation effects on mechanical cell-membrane properties is described. In the intact washed erythrocyte a quantitative study of cell-sphering by x irradiation is made, the sphering being caused by loss of anti-sphering surfactant from the cell surface. This is corroborated by interpretation of electron microscopic pictures of "ghosts" found in the literature. (auth)

15788 THE EFFECT OF DEOXYRIBONUCLEIC ACIDS ON THE INCIDENCE OF CHROMOSOMAL ABERRATIONS IN IRRADIATED AND NON-IRRADIATED BONE MARROW. Z. Karpfel, E. Palecček, and Jana Šlotová (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). p.315-22 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

In experiments on mice the effect of isologous, homologous, and heterologous deoxyribonucleic acids on the post-irradiation regeneration of bone marrow was studied. All DNA samples, with the exception of calf thymus DNA, increased the mitotic activity of irradiated bone marrow. Our quantitative studies have shown that the degree of mitotic activity was not in agreement with the species specificity of the applied DNA. Injections of homologous and heterologous DNA produced an increase in the number of anaphase chromosome aberrations in comparison with irradiated control animals. The incidence of the aberrations was in negative correlation with the degree of phylogenetic relationship between donor and host. Homologous and heterologous DNA increased the number of aberrations in non-irradiated mice. The increase is again dependent on the degree of phylogenetic relationship between the animals in question. After injections of homologous DNA, we found three times more aberrations in irradiated mice compared with the control groups. This effect remained for two months. At the same time the majority of aberrant cells in the control groups was eliminated. Denatured non-isologous DNA did not produce this increase either in normal or in irradiated animals. In subsequent experiments the effect of some mononucleotides and polynucleotides was studied on the mitosis in irradiated and non-irradiated bone marrow. (auth)

15789 THE EFFECT OF RADIATION ON DEOXYRIBONUCLEOPROTEINS. M. Skalka, J. Matyášová, and J. Soška (Inst. of Biophysics, Czechoslovak Academy of Sciences, Brno). p.323-32 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

DNA exists in tissues regularly as a complex with protein. Little attention has been paid to research on the effect of radiation on deoxyribonucleoproteins from the point of view of the bond between DNA and protein until now. Several experiments devoted to this question were carried out. First, the level of so-called deoxyribopolynucleotides was followed (i.e., of free DNA not bound with protein) in various tissues of certain mammals. These substances were estimated, according to Cole et al., as compounds soluble in 0.14 M solution of sodium chloride, precipitated with perchloric acid in concentration of 0.2 M, which gives a positive reaction for deoxyribose with diphenylamine. The normal level of these substances represents, as a rule, a few per cent of the amount of deoxyribonucleoproteins, reaching the highest level in lymphatic and hematopoietic tissues. In other experiments the effect of radiation and of some other factors on the level of deoxyribopolynucleotides, both in vivo and in vitro, were studied. It was established that their amount in vivo increases in mouse spleen after irradiation, and the time course and dose-dependence of these changes were determined. A smaller increase in these substances also occurred after the action of other agents. More experiments were carried out at the same time, giving some information regarding changes in binding between DNA and protein after irradiation. Certain experiments were supplemented by estimation of the tissue content of the sum of deoxyribonucleotides and nucleosides by means of Hoff-Jorgensens' microbiological method. (auth)

15790 EFFECT OF IONIZING RADIATION ON THE CHANGE OF PROPERTIES IN PHAGE LAMBDA. Z. Hradecná, V. Arber, and G. Kellenberger (Univ. of Geneva). p.335-42 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

The action of ionizing radiation and the effect of protective substances on certain properties of the lambda bacteriophage were studied. After exposure to ionizing radiation the bacteria becomes inactive and loses its powers of reproduction. In order to explain the influence of radiation in greater detail the way in which certain of the phage's functions were affected after irradiation was studied. It was found that as a result of ionizing radiation the phage suffers both direct and indirect injury. The latter effect depends on the medium in which the phage is irradiated and affects its adsorption on bacteria and injection of its DNA. If the phage is irradiated in the presence of protective agents, such as cysteine, indirect injury can be avoided, and the phage's functions—adsorption and injection—remain unimpaired, so that it becomes possible to study the mechanism of the direct effect of radiation on the phage's DNA molecules. The phage's radiosensitivity also depends on its DNA content. In irradiating phages with differing DNA contents, it was found that those with most DNA were the most sensitive. The reactivation of the phage after irradiation was studied: (a) photoreactivation; (b) ultraviolet reactivation; (c) reactivation by cross-breeding. They found no evidence of reactivation after exposure to ionizing radiation. An irradiated phage can only be cross-bred with an unirradiated phage, i.e., one with a complete unimpaired genome. It was confirmed that after irradiation the DNA molecule is broken and the irradiated phage loses its capacity for reactivation. The cross-breeding of phages with those of different genetic characteristics explained the part played by injection of the phage's DNA. By studying the frequency of occurrence of recombinants the authors found that the DNA molecule is always injected into the phage by one end. The number of recombinants after cross-breeding with an irradiated phage depends on how far the genetic characteristic lies from the end of the phage's genome. When the genetic sign is closer to the end which is injected first, the number of recombinants increases. There is less likelihood of the DNA molecule being broken in this short segment than there is further away from the site of the injection. (auth)

15791 THE EFFECT OF IONIZING RADIATION ON BACTERIAL VIRUSES AND ON THE CAPACITY OF BAC-

TERIA FOR PHAGE REPRODUCTION. G. E. Fradkin, L. M. Gol'dfarb, and Yu. P. Vinetskii. p.343-57 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In Russian)

Experimental data relating to the action mechanism of ionizing radiation on resting bacteria phages, and to the reproduction of intact phages in irradiated (non-viable) bacteria are presented. The effect of ionizing radiation on the morphology of the phage and its individual structures (DNA) is described. Analysis of electron-microscope plates showing, firstly, phages which have been irradiated and are incapable of reproduction, and secondly, the deoxyribonucleic acids extracted from inactivated and control phages, tend to show that no morphologically visible destructive processes occur in resting biological structures which are exposed to fairly high doses of ionizing radiation. The functional integrity of individual structures in irradiated phages is analyzed and the state of the antigenic, adsorption, and lytic functions (depending on the phages' protein structures) is described. The data presented point to the stability of such functions and to the extreme vulnerability of the reproductive function, which depends on the genetic structure (DNA). The phage is used as a model to analyze the mechanism of the secondary processes of radiation sickness. The conclusion reached is that it is possible for the reactions of radiation damage to develop in time in resting structures. Experimental data are given on the multiple reactivation of phages inactivated by gamma rays, with the indirect effect predominating. It was concluded that multiple reactivation is not possible in these circumstances. The capacity of irradiated bacterial cells to reproduce phages is described. It is shown that bacteria exposed to large doses of gamma radiation (50,000 r) retain their phage-reproductive capacity for the first four hours following irradiation. The data seem to show that the cell enzymes suffer no initial irradiation damage and that the primary biological effect of ionizing radiation on living organisms is mainly due to damage to the genetic structures. On the basis of all the experimental data presented in this paper, it is concluded that resting phages and the phage-bacteria system are suitable biological models for analyzing the mechanism of the injurious action of ionizing radiation on the reproductive processes in all kinds of living matter. (auth)

15792 THE EFFECTS OF IONIZING RADIATION ON THE BIOLOGICAL ACTIVITY OF ISOLATED DNA FROM BACTERIOPHAGE. J. Blok, I. Van Der Sluys, and J. A. Cohen (National Defence Research Organization T.N.O., Rijswijk, Netherlands and Inst. of Radiopathology and Radiation Protection, Leiden). p.359-70 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

From the bacteriophage ϕX174 a single-stranded form of DNA with molecular weight of 1.7×10^6 can be isolated. The biological activity of the DNA can be assessed by determining its infectivity of bacterial protoplasts from which complete phage particles are produced. This system has been used for the study of the action of ionizing radiation on DNA under different conditions of irradiation. (auth)

15793 THE BIOLOGICAL EFFECTS OF P^{32} TRANSMUTATION IN YEASTS. J. Drobník (Charles Univ., Prague). p.371-81 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

The killing effect of P^{32} transmutation was studied in a diploid strain of Saccharomyces cerevisiae and in the respiratory-deficient mutant derived from it. Comparison with uv and beta irradiation was made. The sizes of lethal curves obtained by all three factors are very similar, the RD mutant being more sensitive. Therefore it is possible to discuss the biological efficiency of P^{32} transmutation in relation to uv and beta irradiation. The lethal curves show two fractions of different sensitivity. Proportions of these two fractions depend on the state of growth of the culture. The relative amount of the more sensitive fraction decreases during P^{32} decay, but the form of uv-killing curves typical for both fractions remains of unchanged "multi-hit-type." Therefore overlapping of the action of P^{32} transmutation and uv probably does not exist. Acriflavin, which was present during the last two generations in growing culture, raises sensitivity to P^{32} transmutation and beta irradiation. Ultraviolet sensitivity is apparently reduced, in all probability by the protection of nuclear material. The induction of RD mutations in a respiratory-sufficient strain were also studied. Both P^{32} transmutation and beta irradiation induce these mutations, but with much lower frequency than uv or acriflavin. The effect of P^{32} transmutation or irradiation on the cells of the last two generations in the presence of acriflavin leads to the mutagenic response which is the sum of the effects of both inducers. (auth)

15794 METABOLIC FACTORS IN RADIOPROTECTIVE ACTION. H. A. S. Van Den Brenk and D. Jamieson (Cancer Inst. Board, Melbourne). p.385-97 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Agents which depress oxidative phosphorylation (including 2,4-DNP, 2,4-DNN, 2,4-DCP, salicylic acid, certain phenothiazines and triiodothyronine) show relatively weak or no radioprotective action in vivo in rats. This suggests that energy made available by an accumulation of energy-rich adenosine phosphates is unimportant in the repair of molecular damage caused by ionizing radiations. However, it is found that moderate hypoxia induced in rats by respiring lowered oxygen tensions which are insufficient to cause protection per se, considerably potentiates the radioprotective action of certain uncoupling agents. This phenomenon seems independent of an effect on oxygen consumption, and is inadequately explained on the basis of a reduction in extracellular oxygen tensions. It is suggested that oxidative phosphorylation may be involved in membrane permeability to oxygen and thus affect intracellular gradients of oxygen tension. Whilst this factor seems unimportant for agents which protect under conditions of strict anoxia in vitro and possibly in vivo, it may be of significance to protection in oxygenated cellular systems and give rise to misinterpretations of mechanisms of action. (auth)

15795 REPAIR OF THE PRIMARY CHEMICAL LESION: A UNITARY HYPOTHESIS FOR RADIOSENSITIZATION BY OXYGEN AND PROTECTION BY SULPHYDRYL COMPOUNDS. P. Alexander and M. G. Ormerod (Royal Cancer Hospital, London). p.399-410 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

On exposing the sperm from salmon to γ rays (or fast electrons) the DNA in the nucleus becomes cross-linked if oxygen is absent. In the presence of oxygen both cross-linking and peroxidation of the DNA occurs. These primary radiochemical changes are reduced if the cells are irradiated in the presence of cysteamine. By the use of electron spin resonance it has been possible to establish the

reactions that occur in nucleoprotein. In vegetative cells—as opposed to the sperm heads which contain only nucleoprotein—intracellular SH compounds restore the primary radiation lesion by reaction III so long as oxygen is absent. In the presence of oxygen, reaction II occurs more rapidly than reaction III. Hence repair by intracellular SH compounds cannot occur or is reduced, and this explains why oxygen causes radiosensitization. Added SH compounds like cysteamine provide protection in oxygenated cells because the concentration of SH groups is now sufficiently high for reaction III to compete with reaction II. The well known fact that cysteamine does not offer much protection in the absence of oxygen is also explained since the normal physiological SH compounds are sufficient to effect repair in the absence of oxygen and increasing the concentration of SH groups does not greatly enhance this process. The primary damage produced by densely ionizing radiations is qualitatively different from reaction I and cannot be repaired. This explains why there is no oxygen effect or chemical protection by SH compounds with α rays. Radiosensitization by sulphydryl poisons is readily explicable by this hypothesis. (auth)

15796 THE INFLUENCE OF CYSTEAMINE GIVEN AFTER IRRADIATION ON CHANGES INDUCED IN THE PERIPHERAL BLOOD OF YOUNG MALE RATS BY 235 kvp X-RAYS. M. Dj. Kilibarda and P. W. Dykes (Univ. of Birmingham, Eng.). p.411-20 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

A technique for lowering the temperature of warm-blooded mammals to 0–5°C with the minimum degree of anoxia has been devised using chlorpromazine to assist cooling. Previous studies using this technique have demonstrated little if any protection from cooling on hematological effects induced by 400 rad of 235 kvp x rays. The animals were injected with β-mercaptoethylamine (cysteamine) (150 mg/kg) during the re-warming phase, and measurements were made of the lymphocyte and polymorphonuclear leukocyte counts during the succeeding 15 days. It was found that cooling per se induces a marked polymorphonuclear leukocytosis, which is unaffected by radiation or the administration of chemicals. The marked fall in lymphocyte count induced by irradiation of cooled animals was, however, partially protected against by the administration of the chemical. This protection reached the level of statistical significance on the second and the fifteenth days after irradiation; on day fifteen, lymphocyte counts of the chemically protected and unprotected groups were 72% and 51% of the control values respectively. Changes in body weight failed to reveal a significant degree of protection, although both cooling and irradiation induced a temporary reduction in both weight and growth. It is concluded that some further evidence has been obtained to support the hypothesis that protective chemicals can, under certain circumstances, afford protection against ionizing radiation when given after the radiation has been completed. This protection however is small in magnitude and, under the conditions of the present study, may principally affect tissues capable of repairing the damage. (auth)

15797 RECOVERY EFFECT OF NATIVE LIVER DEOXYRIBONUCLEIC ACID INJECTED INTO LETHALLY-IRRADIATED RATS. I. EFFECT ON THE METABOLISM OF INTESTINAL NUCLEIC ACIDS OF IRRADIATED RECIPIENTS. A. Bećarević, S. Petrović, V. Janković, D. T. Kanazir, and G. Jovicki (Boris Kidric Inst. of Nuclear Sciences, Belgrade). p.421-8 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Rats irradiated with a lethal dose (LD_{100} 30) and treated with native nucleic acid immediately after irradiation survived the radiation syndrome for a period of over 30 days. In order to ascertain the mechanism of the effect of the native nucleic acids used as survival agents, we undertook a study of the metabolism of the endogenous nucleic acids in the liver and intestines of rats irradiated with a lethal dose and treated with highly polymerized deoxyribonucleic acid (DNA) from the liver of non-irradiated rats. Examinations were made on the fourth and ninth days after irradiation and treatment with DNA. Sodium C^{14} formate (specific activity 10.5 mc/mM) was used as a precursor of the endogenous nucleic acids. Each animal was injected with it intraperitoneally, 13 hr before being sacrificed. We followed the incorporation of the precursor in the purines of ribonucleic acid (RNA) and of DNA in the following groups: (1) irradiated rats (LD_{100} 30) (Group B); (2) irradiated rats (LD_{100} 30) treated with native liver DNA (Group A); (3) non-irradiated rats (Group C); and (4) non-irradiated rats treated with native liver DNA (Group D). The results obtained indicate that native liver DNA injected into the animals gives rise to changes in the incorporation of sodium C^{14} formate in the purines of RNA and the liver and intestine DNA of the irradiated animals. For a period of four days after irradiation it was noted that there was an increase in the incorporation of this precursor in the purines of the liver RNA of the animals irradiated and treated with DNA (Group A) as compared with the same RNA constituents of the liver of the untreated irradiated animals (Group B). At the same time the incorporation of this precursor in the purines of RNA and of the DNA of the intestines of all the irradiated animals (Groups A and B) showed an appreciable increase by comparison with the non-irradiated animals (Group C). However, on the ninth day after irradiation and treatment with native liver DNA, the incorporation of sodium C^{14} formate in the purine constituents of both intestinal nucleic acids was nearly normal. These changes in the incorporation of this precursor of the nucleic acids was also noted in the liver RNA on the ninth day after irradiation and treatment. The results obtained to date suggest that native liver DNA, when injected in rats which have been exposed to a lethal dose of radiation, gives rise to normalization of the metabolic activity of the endogenous nucleic acids in the liver and intestines, as indicated by the incorporation of sodium C^{14} formate. The results obtained are discussed. (auth)

15798 EFFECTS OF X-IRRADIATION ON THE METABOLISM OF RIBONUCLEIC ACIDS IN RESTING RAT LIVER. I. DISTURBANCE OF THE METABOLISM OF RAT LIVER SUBCELLULAR RNA FRACTIONS INDUCED BY X-IRRADIATION. II. EFFECTS OF NATIVE HOMOLOGOUS DNA ON THE DISTURBANCE OF METABOLISM OF SUBCELLULAR RNA FRACTIONS INDUCED BY X-RAYS. S. Petrović, D. T. Kanazir, and A. Bećarević, (Boris Kidric Inst. of Nuclear Sciences, Belgrade). p.429-41 of "Biological Effects of Ionizing Radiation at the Molecular level." Vienna, International Atomic Energy Agency, 1962. (In English)

The results presented suggest: changes in the metabolism of RNA in subcellular fractions of resting rat liver, induced by a lethal dose of x irradiation; changes in the structure of the most metabolic RNA in the liver of the irradiated animals; alteration in the proposed conversion of the hypothetic "precursor RNA" into the stable microsomal RNA, induced by irradiation; and a restorative effect of the injected homologous native DNA on the changes in the RNA metabolism and the composition induced by radiation. (auth)

15799 PARADOXICAL MODIFICATIONS IN RADIOSENSITIVITY OF MAIZE AND BARLEY SEEDS STABILIZED FOR DIFFERENT MOISTURE CONTENTS. N. K. Notani and B. K. Gaur (Atomic Energy Establishment, Trombay, India). p.443-53 of "Biological Effects of Ionizing Radiation at the Molecular Level." Vienna, International Atomic Energy Agency, 1962. (In English)

Maize seeds of inbred Oh 51A (after being stabilized for moisture content) when irradiated with gamma-radiation doses of 13.5 to 67.5 kr, showed extreme modifications of radiosensitivity as determined by seedling height and survival. The radiation sensitivity varied by a factor of 5 (for 92% inhibition of growth) with change in moisture content of the seeds. The maximum differential in radiosensitivity was attained with 13.5 kr. In contrast, hulled barley seeds of a local variety, stabilized similarly for their moisture content (1.97 to 12.01%) gave a differential of a factor of less than 2. Besides revealing a maximum differential at 54 kr they showed an increase in radiosensitivity at the highest moisture level (12.01%). It was inferred that seeds equilibrated over a wide range of moisture contents exhibit an increase in radiosensitivity both at low (dry) and high (wet) moisture levels. Moist seeds (intermediate levels of moisture) on the other hand, displayed minimum radiosensitivity. Theoretical considerations of the foregoing observations have allowed formulation of the following working hypothesis, which is based mainly on Power's formal classification, of radiation damage in dry bacterial spores. Essentially, the hypothesis takes into account the role played by SH groups, O_2, and H_2O in the three types of postulated damage to explain the observed departure from the more commonly recognized principle of inverse relationship between radiosensitivity and tissue hydration level. The Class I, O_2-independent component, might be responsive to SH groups since part of it could be nullified by H_2S. On this basis wet seeds should have less damage of this type because of higher respiratory activity with, presumably, a concomitant increase in the SH content. Class II, O_2-dependent damage, on the other hand, should be more evident in wet seeds in view of their higher O_2 consumption. Class III damage, consisting of the free radical component, should be higher in dry seeds because of low mobility and the long life of radicals. In addition to the physicochemical damage, the biochemical injury might be greater in wet seeds than in dry ones. Pooling of the differential damage in dry, moist, and wet seeds gave estimates that approximated the observed damage. (auth)

15800 RADIOACTIVE ISOTOPE THERAPY, WITH PARTICULAR REFERENCE TO THE USE OF RADIOCOLLOIDS. J. H. Muller (Univ. of Zurich, Switzerland). Review Series No. 27 of "Developments in the Peaceful Applications of Nuclear Energy" of the International Atomic Energy Agency, Vienna. 1962. 69p. $1.00, Sch 21, 6s. stg, NF 4, DM 3.20 (IAEA). (STI/PUB/15/27)

Artificial radioactive isotopes represent an important tool in the field of medical therapy, especially for combating cancer and allied diseases. Radioisotopes offer versatile means for the development of radiation therapy along the conventional lines of x ray and radium therapy, and in addition, they open up new possibilities of internal therapy. Localization of the radioisotope through metabolism, as can be done efficiently with radioiodine, may result in total cures of metastasizing thyroid carcinoma. Individuals who would not have survived before artificial radioisotopes became available thus lived and even became parents. Radioactive iodine also offers an excellent means of treating hyperthyroidism. The various internal applications of suspensions of non-soluble particles, or radiocolloids, have assumed considerable importance. Their use for the palliative treatment of widespread incurable malignancy has already been fully accepted. More recently, their employment as a routine complement of surgery and, to some extent, of conventional radiotherapy for the pre- and postoperative control of the micro-dissemination of cancer cells has been studied and is of great importance. The efficiency of such routine administration of a radiocolloid was first demonstrated with respect to ovarian cancer. It will most likely also hold true for further abdominal, thoracic, and many other malignancies, e.g., cancer of the breast. In the case of ovarian cancer the five-year cure rate of the still operable cases can, apparently, be almost doubled by this means. This fact would seem at least as important as a mere prolongation of the life span in desperate incurable conditions, to which so much effort has been devoted. Greater attention ought therefore to be paid to the particularly favorable conditions obtained by a combination of the various procedures using radioactive suspensions of relatively short-lived isotopes with major surgery and radiotherapy of the conventional type. The main advantage lies in an increased blocking of lymphatic dissemination and the sterilization of tumor micro-metastasizations which escape even the most radical surgery and conventional radiotherapy. Such additional isotope therapy will thus reduce the probability of subsequent deaths from hidden, latent metastatic foci, and offers both a technical and tactical means for increasing the efficiency of the fight against malignant disease in the individual cancer patient. In this respect a critical evaluation of obvious correlations between internal radioisotope therapy and cancer chemotherapy indicates the essential curative superiority of radioactive isotopes over chemotherapeutic agents. (auth)

15801 EFFECTS OF IONIZING RADIATION ON A NATURAL PLANT COMMUNITY. J. Franklin McCormick. Thesis, Atlanta, Emory Univ., 1962. 117p.

An "island community" of spring annuals transplanted from a granite outcrop to a γ radiation field received ionizing radiation gradients ranging from 8,000 to 130,000 r at rates of 5 to 82 r/hr from March to August 1959. Ecological analyses of experimental and control communities over the subsequent 3 year period revealed both immediate and long-range effects of ionizing radiation upon individual species and community attributes. Results obtained from community analyses indicate that ionizing radiation has both stimulatory and inhibitory effects upon plant growth and that the ecological and morphological effects are reflected by species interactions at the community level. Results of autecological analyses of the post-irradiation tolerances of spring and summer annuals to a variety of environmental stresses correlate with and confirm results obtained during community analysis. Under all environmental conditions studied, post-irradiation dominant species consistently exhibited greater physiological tolerances following irradiation than did the normally dominant species which they replaced. (M.P.G.)

15802 THE EFFECTS OF IONIZING RADIATION ON THE ECOLOGY OF PINUS TAEDA L. Robert Allan Pedigo. Thesis, Atlanta, Emory Univ., 1962. 132p.

Various aspects of the effect of ionizing radiation on the ecology of loblolly pine (Pinus taeda L.) were studied. The general experimental design treated the mixed neutron-γ or pure γ radiation as an additional environmental factor. Discoloration, death of terminal buds, and inhibition of reproduction begin after exposure to about 1,000 rads, and the accumulation of greater doses results in complete

browning, defoliation and death. The lethal dose for mature plants is about 7,500 rads, but seedling stages are slightly more sensitive, with lethal doses ranging from about 4,500 to 6,500 rads. The sequence of events leading to death requires from 90 to 120 days, and may lead to an overestimation of radiation tolerance as chronically irradiated plants continue to accumulate radiation during the period of the death syndrome. Terminal growth is extremely sensitive to radiation and exhibits a differential resistance depending upon whether terminal or lateral branches are involved. Respiration is relatively unaffected by doses up to 13,000 r, but photosynthetic rates are significantly reduced. A comparison with the methods and results of other works indicate that the reduction in photosynthetic rate is an indirect effect rather than interference with the photosynthetic mechanism itself. Resistance to heat and tolerance to drought and shade are reduced by exposure to radiation. From the ecological point of view the results indicate that loblolly pine is poorly adapted for survival in an irradiated habitat. The relatively low lethal dose results in loblolly pine being selectively eliminated from all of its normal habitats at dose levels that apparently have little effect on many associated species. Even lower doses prohibit the invasion of new areas, and sublethal doses greatly reduce growth, lessening the possibility of successful competition with associated species. Changes in physiological tolerances also reduce the ability to compete in the natural environment. (M.P.G.)

Radiation Sickness

15803 (SAM-TDR-62-85) RADIOPROTECTIVE AGENTS. THE EFFECTS OF DEPOLYMERIZED YEAST RIBONUCLEIC ACID ON RADIATED HUMAN CELLS IN TISSUE CULTURE. Donald E. Rounds and William C. Slick (Pasadena Foundation for Medical Research, Calif.). Oct. 1962. Contract AF41(657)-337. 4p.

Yeast ribonucleic acid was hydrolyzed with NaOH to produce polynucleotide mixtures which were tested for radioprotective activity on cultured cells. The depolymerized RNA stimulated the growth rate of amnion cells during 5-day treatment periods, but had no effect on growth when the cells were treated for a 24-hour period. A 24-hour treatment of amnion cells with the nucleotide mixture prior to 700 r gamma radiation resulted in an increase in the surviving cell populations. This effect appeared to reach a maximum with a polynucleotide concentration of 0.3 mg/ml. The RNA hydrolysate had no significant effect on radiated KB cells, but surviving HeLa and amnion cell populations were increased by 19% and 63%, respectively, over controls. This radioprotective response was detected after a minimum of 4 hours of treatment of amnion cells with the test material. (auth)

15804 (USNRDL-TR-606) EFFECTS OF DIVIDED DOSES OF X RAY ON MORTALITY AND HEMATOLOGY OF SMALL AND LARGE DOMESTIC ANIMALS. G. F. Leong, W. G. Wisecup, and J. W. Grisham (Naval Radiological Defense Lab., San Francisco). Jan. 7, 1963. 25p. (AD-297412)

An attempt was made to establish a correlation of systemic recovery with hematological recovery after x radiation exposure for the mouse, rabbit, sheep, and goat under uniform experimental conditions. By separating these animals into two broad groups, small and large animals, significant differences were demonstrated as to their $LD_{30/30}$, hematological recovery, and systemic recovery. Furthermore, a significant departure from the generally accepted exponential recovery after a radiation insult is shown for both small and large animals. The need for a more critical analysis of recovery at intervals well past the recovery half-time is indicated in evaluating rates of recovery. (auth)

15805 (JPRS-18153) CLINICO-MORPHOLOGICAL CHARACTERISTICS OF CHRONIC RADIATION SICKNESS INDUCED EXPERIMENTALLY BY MEANS OF EXTERNAL IRRADIATION. N. N. Garvei (Garvey), E. (Ye.) M. Politova, and G. N. Yelpat'evskaya (Yelpat'yevskaya). Translated from Gigiena Truda i Prof. Zabolevaniya, 6: No. 12, 26-33(1962). 11p. (OTS-63-21332)

Chronic radiation sickness developed in rats exposed to daily doses of 0.5 r x radiation for a period of 6 mo. Clinical observations, laboratory data, and results of pathological-anatomical examinations are summarized. The basic criteria in the diagnosis of chronic radiation sickness during the early period were blood disorders in the hematopoietic organs. (C.H.)

15806 SARCOMA-LIKE TUMORS OF THE SKIN FOLLOWING IRRADIATION. Nikolai Rachmaninoff, John R. McDonald, and James C. Cook (Harper Hospital, Detroit). Am. J. Clin. Pathol., 36: 427-37(Nov. 1961).

Between 1931 and 1960, 32 patients with tumors of the skin after application of irradiation for benign conditions were examined. Histologic diagnoses revealed 6 patients to have multiple tumors: 5 had sarcoma-like tumors of the skin (2 as the only lesion and 3 associated with squamous and basal cell carcinomas). Histologic findings of the sarcomas varied greatly from fairly orderly interlacing bundles of spindle-shaped cells of connective tissue, having moderately hyperchromatic nuclei, to poorly differentiated fibroblastic lesions, having bizarre mitotic figures, giant nuclei, and almost complete lack of collagen formation. None of the tumors metastasized, and, where wide resections or amputations were performed, there was no evidence of recurrence. The patients were free of their disease except 2 in which fatal squamous cell carcinoma or lymphoma subsequently developed. It was concluded that the diagnosis of a fibrosarcoma in the fibroblastic growth after irradiation of the skin cannot be substantiated on histologic criteria alone. (P.C.H.)

15807 RADIATION INJURY TO THE RECTUM AND SIGMOID COLON. Lamar M. C. Smith, Jr., William N. Viar, Joseph M. Donald, and Gus W. Colvin. Am. Surgeon, 27: 660-4(Sept. 1961).

Bowel damage following x-ray and radium therapy of cervical carcinoma are described. Symptoms of abdominal pain, tenesmus, and the passage of blood from the rectum are typical signs of injury although the character of the symptoms vary with the type and extent of intestinal pathologic condition. Stages of pathology are classified. In general, acute proctitis (stage 1) usually subsides spontaneously or responds to a bland or low residue diet, sedation, antispasmodics, and intestinal antibiotics. Similar treatment is recommended for ulceration with proctitis (stage 2), but during this treatment the patient must be under careful observation because of the possibility of complications of severe bleeding, intestinal obstruction, or perforation of the bowel, which usually require surgery. Irradiation necrosis of the bowel is influenced by mechanical factors, such as positioning of radium applicators, position of the uterine fundus, normal anatomic proximity of the rectum to the cervix, and the presence of adhesions holding small or large bowel in a constant position within radiation range. All contribute toward possible irradiation overdosage to the

intestine and particularly the rectum and sigmoid colon. (P.C.H.)

15808 TOTAL IRRADIATION WITH X RAYS AND ADRENAL ACTIVITY. W. Eechaute, G. Demeester, and I. Leusen (Université, Ghent.). Arch. Intern. Pharmacodyn., 135: 235-48(1962). (In French)

Adrenocortical steroid synthesis was evaluated in vitro after whole-body irradiation of rats with 750-r doses of 250-kv x rays. This was done by measuring corticosterone formation in adrenal slices 2 to 116 hr after irradiation. Plasma corticosterone levels were also followed over the same period. The plasma level rose to 5 times the normal value $2\frac{1}{2}$ hr after irradiation, fell to normal after 24 hr, and rose to very high levels (5 to 12 times normal) just before death. The plasma values were closely paralleled by changes in in vitro corticosterone synthesis. The synthesis rates at 2, 24, 72, and 116 hr after irradiation were: 3.3, 1.7, 2.8, and 4.6 μg/hr/2 glands, compared with the control value of 1.8. Both the plasma level and adrenal synthesis rate of corticosterone were highest in the terminal phase of acute radiation sickness. The weight of the adrenal glands was ~ twice as high in the terminal phase as in unirradiated rats. When the change in weight was considered, corticosterone production per unit weight of adrenal tissue was elevated 2-fold 2 hr after irradiation but later did not differ significantly from normal, showing that the terminal hyperactivity was due to hypertrophy of the gland. (P.C.H.)

15809 2-METHYLPIPERAZINE DITHIOFORMATE: A NEW LIVER AND RADIO PROTECTOR. V. Palmo, G. Galli, S. Garattini, R. Paoletti, and R. Vertua (Università, Milan, Italy). Arzneimittel-Forsch., 11: 1034-7(1961). (In English)

A series of dithiopiperazine derivatives was studied for possible protective activity against agents inducing liver degeneration and the damage induced by x irradiation. The most active agent tested was 2-methylpiperazine dithioformate (DTP). DTP injected intraperitoneally had an LD_{50} of 740 mg/kg in mice and 2000 mg/kg in rats by the oral route. It afforded rats protection against the liver injury induced by feeding a high-fat diet, pyridine, or ethionine. DTP was much more effective than cysteamine or methionine in preventing hepatic necrosis induced by a combined x irradiation and carbon tetrachloride treatment. However, in rats given a single whole-body 1000-r dose of x irradiation, DTP was slightly less effective than cysteamine in prolonging survival (20 vs 32 days compared with 8 days in untreated control rats). It also partially blocked the fall in intestinal DNA content induced by irradiation or by nitrogen mustard treatment. (H.H.D.)

15810 REACTIVATION OF ERYTHROPOIESIS BY COBALT AFTER RADIATION INJURY. Jouko Saikkonen and Eino Marttinen (Univ. of Helsinki). Blood, 21: 39-50 (Jan. 1963).

The ability of Co to prevent anemia following whole-body radiation injury was tested. Albino rats were exposed to a single x-ray dose of 250 or 350 r after which one-half were treated with daily subcutaneous injections of Co while the others were given saline injections. A daily dose of 0.8 mg of Co/kg body weight was administered 1 hr after exposure. Treatment was continued over a period of 8 weeks, and the hemoglobin and erythrocyte counts were measured once a week. Rats exposed to 250 r and thereafter treated with Co showed reactivation of erythropoiesis after 1 to 2 weeks and then rapidly developed polycythemia, in contrast to the similarly irradiated rats afterwards treated with saline, which after 8 weeks still had blood values below the original level. In rats irradiated with 350 r, the same phenomenon was seen, although the effect of Co became apparent slowly. The findings observed in the peripheral blood were confirmed by checking the bone marrow of rats given 350 r. The toxicity and mode of action of Co are also discussed. (P.C.H.)

15811 EFFECTS OF SPLENECTOMY AND OF TREATMENT WITH SPLEEN HOMOGENATES IN ANIMALS SUBJECTED TO WHOLE-BODY IRRADIATION. P. De Franciscis, S. Cifaldi, and V. Muto (Università, Naples). Boll. Soc. Ital. Biol. Sper., 37: 809-11(Sept. 15, 1961).

Male mice were given a single whole-body dose of 1000-r, 160-kv x rays 10 days after splenectomy or immediately before injection of homogenized spleen. The homogenate was injected intraperitoneally in an amount equivalent to a single spleen; some controls were injected with spleen that had been boiled for 5 min to denature proteins. The 10-day mortality rate was 60% in untreated controls, 23% in splenectomized animals, and 25 and 90% in animals given fresh and heat-treated spleen homogenate, respectively. The 15-day mortality rates in the 4 groups were 75, 50, 40, and 90%, respectively. The results show that prior splenectomy has a similar protective effect to injection of fresh spleen, whereas injection of heated spleen markedly increases radiosensitivity. The protective factor in spleen, therefore, is a thermolabile substance, possibly protein in nature. (H.H.D.)

15812 CONTRIBUTION TO THE IDENTIFICATION OF THE SPLEEN FACTOR PROTECTIVE AGAINST THE RADIATION SYNDROME. P. De Franciscis, V. Muto, and S. Cifaldi (Università, Naples). Boll. Soc. Ital. Biol. Sper., 37: 811-3(Sept. 15, 1961).

Attempts were made to elucidate the nature of the heat-labile protective factor in spleen homogenate by experiments in mice. Spleen homogenates were dialyzed at 4°C against physiologic saline solution for various periods and under various conditions and were then injected into lethally (1000 r) irradiated mice. Whereas whole spleen homogenate (equivalent to one spleen) reduced the 10-day mortality rate by 50%, various dialyzed fractions afforded only slight protection. The dialysis fluid, after concentration by redialysis against polyvinylpyrrolidone, conferred no protection. Similar changes were noted with respect to 15-day mortality. The inactivation of the radioprotective factor in spleen by dialysis and heat suggests that it may be a low molecular weight protein or peptide. (H.H.D.)

15813 OILS, LIPOXIDASE, AND IONIZING RADIATIONS. J. Cheymol, M. Adolphe, and F. Heitz (Institut de Pharmacologie de la Faculté de Médecine, Paris). Bull. Acad. Natl. Med. (Paris), 145: 518-22(Oct. 10, 1961).

The radioprotective effect of olive oil was investigated to ascertain whether action can be attributed to the antiperoxide effect of the oil. Mice were given 400-r whole-body x irradiation (the 30-day LD_{50} value) before or after injection of olive oil. Some mice were also injected with lipoxidase to investigate the possibility of neutralizing the effect of the oil. When the oil was injected 30 min after irradiation, it slightly aggravated the effect of irradiation, in contrast to the earlier findings. When it was given 60 min before irradiation, no radioprotective effect was evident. Injection of olive oil plus lipoxidase had no effect whatever on the mortality curve over a 20-day period. (P.C.H.)

15814 SPLENIC AND BONE MARROW HOMOGRAFTS IN THE DOG AFTER LETHAL TOTAL-BODY IRRADIATION. J. W. Irvine and S. Kling (Univ. of Alberta). Can. J. Surg., 4: 593-7(Oct. 1961).

Since the injection of bone marrow alone appears to give inadequate protection against the lethal effects of radiation in dogs, an experiment was designed to remedy this by the transplantation of spleen as a source of lymphocytes. Four control dogs given 1000-r Cs^{137} radiation lived 3 to 8 days or an average of 5.5 days. After whole-body irradiation and bone marrow homotransplant the survival time of 5 dogs was from 4 to 13 days with an average of 7.4 days. In 5 dogs receiving 1000 r, bone marrow, and splenic whole-organ homotransplants, the survival times ranged from 3 to 6 days with an average of 4.6 days. There was necrosis of splenic cells, either partial or complete, and leukocyte and platelet counts decreased as in the control group. In 6 dogs receiving 1000 r, bone marrow, and splenic pulp homotransplants, the survival times ranged from 4 to 43 days with an average of 14.2 days. In 5 of the 6 dogs there was a typical decrease in the leukocyte and platelet counts, with death due to the effects of acute irradiation or to infection. In the dog that survived 43 days a return of circulating neutrophils and platelets occurred. It was concluded that the bone marrow and possibly the splenic cell transplant were a success and that the tissues were destroyed later by return of the dog's own immune response mechanism. (P.C.H.)

15815 THE EFFECT OF LOW DOSES OF POLONIUM ON INTESTINAL MICROFLORA OF DOGS AND SOME INDICES OF NATURAL IMMUNITY. O. R. Nemirovich-Danchenko. Federation Proc., Transl. Suppl., 22: No. 2, Pt. II, T226-8(Mar.-Apr. 1963). (Translated from Zh. Mikrobiol. Epidemiol. i Immunobiol., No. 2, 56-62(Feb. 1962)).

The subcutaneous injection of dogs with 0.01 mC/kg Po induced a subacute form of radiation sickness accompanied by marked changes in the intestinal microflora and in some other indices of natural immunity. The use of 0.001 mC/kg Po caused chronic radiation sickness, also accompanied by changes in the intestinal microflora and other indices of immunity. Abnormalities noted in the intestine and other indices of reactivity were of the same character as the changes associated with the subacute and acute forms of radiation sickness, but they were less intense, varying with the severity of the particular case of radiation sickness. (P.C.H.)

15816 OOCYTE MATURATION DIVISION IN THE MAMMALIAN OVARY DURING VARIOUS PHASES OF THE ESTROUS CYCLE AND IN ACUTE RADIATION. Ya. Karmysheva (Pavlov Medical Inst., Ryazan, USSR). Federation Proc., Transl. Suppl., 22: No. 2, Pt. II, T314-16(Mar.-Apr. 1963). (Translated from Byul. Eksperim. Biol. i Med., 53: No. 2, 93-6(Feb. 1962)).

An investigation was made on the process of oocyte maturation in normal and irradiated mice. The mice were subjected to 400-r x rays. The number of dividing oocytes was counted in all the ovaries and the number of corpora lutea was computed from reconstructions of the serial sections. The results were statistically processed by the Fisher-Student method. An increased number of oocyte maturation divisions observed in white mice from the 2nd to the 14th day after irradiation was found to be due to x-ray injury to the ovaries and acceleration of the process of atresia. An increase in the number of ovulations was probably due to certain neuro-humoral changes induced by ionizing radiation. (P.C.H.)

15817 MORPHOLOGIC CHANGES IN THE LIVER RELATIVE TO THE FUNCTIONAL STATE AT TIME OF IRRADIATION. N. V. Sokolova and T. I. Gorshenina (Tomsk Medical Inst., USSR). Federation Proc., Transl. Suppl., 22: No. 2, Pt. II, T317-19(Mar.-Apr. 1963). (Translated from Arkh. Patol., 24: No. 4, 50-5(1962)).

Experiments were made to correlate radiation damage with the functional loading and with bile secretion during irradiation in mice. Radioinduced morphologic changes were most prominent in parts functionally stressed at the time of irradiation. Depending on the action mechanism of the preparation administered, whole-body irradiation of animals after the administration of choleretics causes primary damage of the parenchymal (tansy) or reticuloendothelial (chologon) elements of the liver. (P.C.H.)

15818 DISTURBANCES OF CELL DIVISION WITH X-RAY INJURY OF THE CRYSTALLINE LENS. A. N. Faddeev (Ternopol' Medical Inst., USSR). Federation Proc., Transl. Suppl., 22: No. 2, Pt. II, T320-5(Mar.-Apr. 1963). (Translated from Tsitologiya, 4: No. 2, 193-200 (Mar.-Apr. 1962)).

Irradiation of the crystalline lens with various cataractogenic doses of x rays (900, 1600, 5100 r) caused the same disturbances of cell division in the epithelium as in other tissues of animal origin. After the influence of radiation, proliferation of the epithelium ceased. The period of depression lasted from 3 to 14 days, depending on the size of the dose, after which pathologic mitoses appeared. The most profound changes in cell division developed after irradiation with a dose of 5100 r. With this dose, during the period of increased mitotic activity and later, karyokinesis was replaced by direct division of the nucleus in the form of budding or constriction. Pathologic division products underwent degenerative, necrotic changes and finally died under the anterior or the posterior capsule of the crystalline lens. The lack of a special mechanism for the removal of the atypical cells, which form as a result of chromosomal aberrations, pathologic karyokinesis, or amitosis can be considered a characteristic peculiarity of cell division pathology attending x-ray injury of the crystalline lens. (P.C.H.)

15819 CAUSE AND PROGNOSTIC SIGNIFICIANCE OF IRRADIATION LEUKOPENIA. D. Schoen (Universität, Tübingen, Ger.). Fortschr. Gebiete Roentgenstrahlen Nuklearmed, 98: 173-80(Feb. 1963). (In German)

In order to clarify the prognostic significance of irradiation leukopenia, the relations between length of survival and leukopenia were examined in 185 patients with bronchial carcinomas. It was not possible to demonstrate a statistically significant negative correlation between them. The results of a similar investigation concerning 280 cases of carcinoma of the breast are then outlined. If attention is paid to the frequency and time of occurrence of metastases, no difference could be demonstrated in the survival of women with or without leukopenia. It was observed, however, that the reduction in number of leukocytes in the peripheral blood depends on their initial numbers, on body weight, and body surface area (used as an index of body volume). The cause for the leukopenia is thought to be radiation damage due to scatter, which cannot be recognized morphologically. In some cases, radio induced leukopenia may be the result of auto-immune processes. (auth)

15820 SOME HEMATOLOGICAL VIEWPOINTS ON SUPERVOLTAGE THERAPY. B. Chonê (Universität, Heidelberg). Fortschr. Gebiete Roentgenstrahlen Nuklearmed., 98: 181-6(Feb. 1963). (In German)

Methods that may be used in order to clarify the etiology of a possible radio-induced disturbance of hematopoiesis are described and illustrated by a number of clinical examples. In addition to bone marrow aspiration, particular at-

tention is paid to the Pyrexaltest, which provides a functional view of leukocyte production. (P.C.H.)

15821 AUTOLOGOUS BONE-MARROW TREATMENT OF LETHALLY-IRRADIATED RHESUS MONKEYS. R. R. Schofield, Mary V. Haigh, and Edith Paterson (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Intern. J. Radiation Biol., 6: 1-16(Jan. 1963). (In English)

Nineteen rhesus monkeys were irradiated at doses of 800 to 890 rads of x rays and each transfused with nucleated cells obtained from its own marrow cavity. Seven treated in this way and not routinely treated with antibiotic died, though one had a largely re-populated marrow. The remaining twelve were treated routinely with penicillin and tetracycline in addition to the bone-marrow transfusion. Five of this group have survived for at least a year from the time of irradiation and are still alive and healthy. One other lived for 49 days and had complete marrow recovery, but lost weight continuously to death. Results suggest that the number of cells injected does not materially alter the chances of survival, provided they are sufficient to assist in earlier re-population of the marrow. One monkey was given homologous lymphoid cells as well as autologous marrow cells and appeared at autopsy to have more severe damage to spleen, lymph nodes, and marrow and to be more heavily infected than another monkey irradiated in parallel and given bone-marrow alone. A third in the group, irradiated, treated with autologous marrow and autologous lymphoid cells, was similar to the second (control) animal, but lived longer and had somewhat better repopulation of lymphoid tissue. Marrow alone was not sufficient to protect against 800 rads. (auth)

15822 ON THE EFFECTS OF DEPILATORY ROENTGEN IRRADIATION AND OF CONCOMITANT ADMINISTRATION OF CORTISONE ON HAIR GROWTH IN MICE. Ruth W. Sherwin, Sonia D. Morrill, Franz Herrmann, and Earle W. Brauer (New York Univ., New York). J. Invest. Dermatol., 37: 13-23(July 1961).

The effects of irradiation with 500 and 1000 r on the fur of Swiss albino mice were studied, each dosage applied during hair follicular growth and during hair follicular rest, respectively. The same irradiation effects were studied in cortisone-injected mice. The immediate response was characterized by epilation of the growing hairs; the late response by shedding of the club hair and irregular, poor growth of subsequent hair generations. Exposure to 500 r during anagen (the growth phase) produced epilation of the growing hair, with no discernible late damage. Exposure to 1000 r during anagen produced epilation of the growing hair, followed by late effects, namely, shedding of the club hair and defective growth of the subsequent hair generations. Exposure to 500 r during telogen (resting phase) did not result in any gross changes. Exposure to 1000 r during telogen failed to cause an immediate effect, but was followed by loss of the club hair and subsequently by delayed, irregular, and poor growth of the new hair. In the 2 groups of mice (exposed to 500 r and to 1000 r) in which cortisone was injected at the time when hair follicular growth was due to occur, a substantial number of animals failed to show anagen hairs. No modification of the radiation effects by cortisone was observed in the mice injected during telogen. It was concluded that it is possible to epilate growing hair in mice by means of an x-ray dosage moderate enough to prevent damage to subsequent hair growth. Resting hair cannot be removed in this manner. Cortisone, interfering with hair follicular growth, can impair successful epilation of growing hair. (P.C.H.)

15823 CARCINOGENIC EFFECT OF PROLONGED EXPOSURE TO GRENZ RAY. Edward M. Shapiro, John M. Knox, and Robert G. Freeman (Baylor Univ., Houston, Tex.). J. Invest. Dermatol., 37: 291-7(Oct. 1961).

Mice were exposed to grenz ray in low dosage (50 to 100 r/day) over a prolonged period (up to 9 months), giving a total dosage of 20000 or 30000 r. Following irradiation they were kept under observation for a period of 1 year. No conclusive differences in longevity of irradiated and control groups were noted. The antimalarial drugs, Triquin and chloroquine, which initially appeared to offer some protection to the skin of the ears did not prevent the development of squamous cell carcinomas. Squamous cell carcinomas were produced in 22% of mice receiving a total dose of 30000 r of grenz ray but none occurred in those receiving only 20000 r. Additional changes consisting of dorsal hair loss and telangiectasia plus slight thickening of ear margins were noted in all irradiated animals but the changes were less severe in the groups receiving only 20000 r. It was found that grenz rays appear to be similar to x rays in yielding a postirradiation carcinogenic effect. Most of the tumors formed were on the back, face, or neck; only 1 formed on an ear. All other tumors that developed were of breast origin of a type that apparently occurs spontaneously in this strain of mice. It was concluded that the squamous cell carcinomas that developed are attributable to the grenz rays. (P.C.H.)

15824 CHARACTERISTICS OF ABNORMALITIES OBSERVED IN ATOM-BOMB SURVIVORS. T. Misao (Kyushu Univ., Fukuoka). J. Radiation Res., (Japan), 2: 85-97(1961).

Physical and psychosomatic examinations were performed on 356 A-bomb survivors during the 4-yr period 1955–1959. In somatic aspects, 172 of the 356 survivors complained of fatigue and vertigo, 118 of whom had had no corresponding explanation. There was no significant change in the blood and bone marrow other than a tendency to a higher incidence of either anemia, leukopenia, thrombocytopenia, or their combination, particularly in those who had been exposed at a small distance from the hypocenter. In psychosomatic aspects, almost all the survivors had some complaints such as anxiety, a feeling that their lives were hopeless, and fear of A-bomb effects on their descendants. Bodily complaints seemed to stem from a neurotic basis. Since information on sequelae of A-bomb disease has come mainly from mass communication sources (67%) and also partially from physicians (21%), it should be emphasized that both mass communication sources and physicians must be very cautious in describing the morbid sequelae. (P.C.H.)

15825 THE INCIDENCE OF LEUKAEMIAS IN HIROSHIMA DURING THE PAST FIFTEEN YEARS FROM 1946 TO 1960. S. Watanabe (Hiroshima Univ.). J. Radiation Res. (Japan), 2: 131-40(1961).

The incidence of leukemia among those who were exposed to the atomic bomb at a distance of less than 5000 m from the hypocenter was higher than among non-exposed persons. It began to rise from 1947 and maintained a high level during 1948 to 1959 to form a plateau ranging from the maximum incidence of 774 per 100000 in 1951 to the miminum of 92 in 1952. It was not until 1960 that the incidence began to decline rather sharply. The ratio of the acute form of leukemia to the chronic form was markedly higher among people exposed at a short distance from the hypocenter than among non-exposed people. The ratio decreased as the distance increased. It must be noted, however, that the high value of the ratio was significantly different from that of non-exposed persons only until the distance reached

5000 m from the hypocenter. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

15826 SOME RECENT STUDIES OF CHEMICAL PROTECTORS AGAINST RADIATION. H. J. Melching (Universität, Freiburg i. B.). J. Radiation Res. (Japan), 3: 31-40 (Mar. 1962). (In English)

The protective effects of various chemicals, such as benzedrine, pervitine, reserpine, noradrenaline, 1-adrenaline, 5-hydroxytryptamine, tryptophane, 5-hydroxytryptophane, pyridoxal-5-phosphate, adenosine triphosphate, and adenosine monophosphate, against radiation damage in mice were studied. The protective mechanisms afforded by the various chemicals are also discussed. (P.C.H.)

15827 ON THE ACTION MECHANISM OF RADIATION PROTECTION SUBSTANCES IN MAMMALS. H. Langendorff (Universität, Freiburg i. B.). J. Radiation Res. (Japan), 3: 41-7(Mar. 1962). (In German)

The free radicals produced in enzymes in organisms by irradiation are captured by the foreign materials (radiation-protection agents) or their formation is reduced by the presence of the foreign materials. The ion yield also causes inactivation of the irradiated enzyme. The assumption that the only effective radiation-protection substances are those that have a free SH group as well as an NH_2 group in the molecule is presented. Results of studies are given in support of this view. Five classes of protective materials are discussed: SH-containing compounds, pharmacologically active compounds, metabolites, compounds with special characteristic action, and vitamins and hormones. (M.C.G.)

15828 STUDIES ON THE BLOOD PICTURE AND BONE MARROW FUNCTION TEST OBSERVED IN 1961 ON 131 A-BOMBED SURVIVORS IN FUKUOKA AND SAGA PREFECTURES. Tando Misao (Kyushu Univ., Fukuoka, Japan), Kenichi Hattori, Morio Ito, Seizo Kuraoka, Tomonori Kamatani, Hajime Fukuta, Ryuzo Mikawa, Satoshi Hitsumoto, Nobuki Endo, and Yasushi Kishikawa. J. Radiation Res. (Japan), 3: 79-88(June 1962). (In English)

Complete blood counting on 131 A-bombed survivors in Fukuoka and Saga Prefectures and bone marrow function test by the use of cobalt-chlorophyllin on 40 survivors were carried out in 1961. The hematological examination revealed a slight, insignificant decrease in hemoglobin, red blood cells, thrombocytes, and leukocytes, and a significant increase in color index compared with normal values. Local analysis revealed that the average values of hemoglobin, red blood cells, thrombocytes, leukocytes, and neutrophils of survivors in Tagawa District (Fukuoka) were lower than the normal values and those in Northern Kyushu District, and that of color index was higher than normal values. The changes were found to be statistically significant. Study on bone marrow function revealed that there were 21 hypofunctional cases (52.5%) and 19 normal cases (47.5%). The average values showed significant decreases compared with normal values. Regarding its relation to other factors, the results of the function test correlate, to some degree, with the blood picture, but neither to the bone marrow picture nor to the hypocentric distance at which the survivor was exposed. The reasons for the contradictory results are considered in detail. (auth)

15829 LEUKAEMIA AND IONIZING RADIATION IN JAPAN. AN EPIDEMIOLOGICAL SURVEY. Masatoshi Sakka (Tokyo Univ.). J. Radiation Res. (Japan), 3: 109-19 (June 1962). (In English)

Dependence of the recent increase in leukemia on the levels of environmental radiation was analyzed. The main sources of information were: correlation of levels of terrestrial radiation and leukemia mortality in some districts in Japan; correlation of an increase in diagnostic x-ray procedures and leukemia mortality in the general population; and interrelationship of the number of radiographers and their leukemia mortality. None of them could give clear evidence that leukemia mortality increased with an increase in radiation doses received by the population at large. It seems reasonable to believe that environmental radiation, natural or man-made, though not to be neglected, plays a subordinate role in the production of spontaneous leukemia. (auth)

15830 SINGLE DOSE X-RAY RADIATION TO THE LUNG AND POSTERIOR MEDIASTINUM THROUGH THE OPEN CHEST. III. RESULTS IN DOGS RECEIVING DOSES OF 2000 r AND 3000 r. John J. Fomon, Frank T. Kurzweg, Marvin B. Slotkin, and Harold Davis (Univ. of Miami, Fla.). J. Thoracic Cardiovascular Surg., 41: 587-93(May 1961).

The advantages of direct irradiation of pulmonary carcinomas over external chest irradiation were studied. In dogs submitted to intrathoracic irradiation, radiation sickness was absent and leukopenia did not develop even with high doses. The dogs remained asymptomatic and in good health until shortly before dying of a complication of the radiation administered. Observations were also made to determine the safe maximum single dose of x rays that can be administered. Thoracotomies were performed on 2 series of dogs receiving 3000 or 2000 r as a single dose without interposition of the chest wall. Each series was divided into 3 groups. Groups I and III had the inflated lung radiated directly through portals of 25.2 cm^2 and 102.1 cm^2, respectively. In Group II the posterior mediastinum was directly radiated over a 26.2 cm^2 area. All animals except 3 died of complications resulting from irradiation. The median survival times were computed and compared with dogs receiving higher doses. The maximum safe intrathoracic dose in dogs appears to be 1500 r. The data indicate that 1000 to 1500 r can be safely administered as a single dose, and that radiation sickness will be absent. (P.C.H.)

15831 THE MODIFICATION OF THE METASTASIS FREQUENCY AFTER WHOLE-BODY X IRRADIATION IN ANIMAL EXPERIMENTAL MODEL RESEARCH. H. Kallenbach and A. Gregl (Universität, Gottingen, Ger.). Med. Klin. (Munich), No. 38, 1621-3(1962). (In German)

In animal experimental model research the single exposure of whole-body x radiation of over 100 r causes a significant resistance increase of the host organism, and therefore an increased formation of "hematogenic metastasis" occurs after injection of tumor cells into the blood circulation. After this original decrease of the defense of the host organism, a relative rise occurs, and then a decrease below that of the controls. Conclusions permitted from current knowledge of these animal experimental research were extended to the clinic. (tr-auth)

15832 THE TREATMENT OF THE SO-CALLED RADIATION HANGOVER WITH PHENOTHIAZINES. J. Hahn. Med. Klin. (Munich), No. 44, 1870-3(1962). (In German)

The so-called radiation hangover (nausea, vomiting, and similar complaints in patients receiving radiotherapy) and its therapy in 545 women with a genital carcinoma were described. Therapeutic studies with the phenothiazine derivative Megaphen (103 cases) and Nipodal (269 patients) were carried out. The good effect of Nipodal was emphasized. (tr-auth)

15833 CHEMICAL PROTECTION FOR THE INCORPORATION OF PHOSPHORUS-32 INTO NUCLEIC ACIDS OF LYMPHATIC CELLS AGAINST γ-IRRADIATION. Ichijiro Honjo, Yuong-Tchel Tchoe, Yasuhiko Takamori, and Mitsuhiko Akaboshi (Osaka Univ.). Nature, 197: 914-15(Mar. 2, 1963).

The protective effects of cysteamine and s,2-aminoethylisothiuronium (AET) for the incorporation of P^{32} by lymphatic cells were measured. Lymphatic cells were irradiated in vitro with Co^{60} γ rays either immediately before or 5 to 10 min after the addition of cysteamine or AET in various concentrations. Desoxyribonucleic acid, ribonucleic acid, and organic acid-soluble phosphate were isolated and the specific activity of each fraction was determined as c/min/μg phosphorus. Results indicate that the threshold for the response of lymphatic cells to γ radiation, measured by the incorporation of P^{32} into nucleic acids, is about 10 r. Cysteamine was effective when present at the time of irradiation and AET failed to give protection for the incorporation of P^{32} into lymphatic cells. (C.H.)

15834 IONIZING RADIATION AND HUMAN LEUKEMIA. Richard K. Blaisdell (Univ. of Chicago). Postgrad. Med., 31: A61-6(Mar. 1962).

The incidence of leukemia in man and various possible etiologic factors are discussed, including genetic aspects, chemical agents, viruses, and ionizing radiation. The risk is such that at a 100-rad dose level leukemia would be expected to develop in only about one person out of 100 over an average lifetime of the survivors, assuming continuation of past incidence rates. Above 100 rad, the higher the dose, the greater the risk. The induction or latent period between exposure and the appearance of leukemia may be as short as 18 months and as long as 14 yr. Acute leukemia and chronic granulocytic leukemia (but not chronic lymphocytic leukemia) are the hematologic types related to radiation exposure. Although the young may be more susceptible to leukemia as a consequence of irradiation, the question of a higher incidence of luekemia among children who have been exposed to diagnostic x rays in utero remains unsettled. It seems improbable that the present amounts of radiation exposure in the U. S. are playing a significant role in the overall current incidence of leukemia. (P.C.H.)

15835 NEOPLASIA EXPERIMENTALLY INDUCED BY BERYLLIUM COMPOUNDS. G. W. H. Schepers (E. I. du Pont de Nemours and Co., Wilmington, Del.). Progr. Exptl. Tumor Res., 2: 203-44(1961).

Of 7 beryllium compounds studied in 38 experiments in 7 mammalian species, $BeSO_4$, BeF_2, $BeHPO_4$, $BeZnMnSiO_4$, and BeO were proved carcinogenic. Ten histologic varieties of malignant tumors were found, including adenocarcinoma (acinar, palligerous, mucigerous), epidermoid carcinoma (with and without keratinization), mixed carcinoma, pleural mesothelioma, and alveolar cell carcinoma (intramural, deciduous, intra-alveolar). Reticulum cell sarcoma of lymph nodes and osteogenic sarcoma also occurred. Tumors were successfully homotransplanted through 5 generations. A close parallel between the progressively accumulated Be in lung tissue and occurrence of lung cancers was established by means of serial spectrographic analyses. The enhanced presence of Be in the lung coincided with greatly increased prevalence of lung cancers at this time. Exposure to $ZnMnBeSiO_4$ (a fluorescent tube phosphor) carried a relatively high mortality and evoked a number of pulmonary lesions prior to the emergence of new growths. Focal cellular reactions, inflammatory processes, emphysema, and abscess formation were induced by the inhaled $ZnMnBeSiO_4$, and tumors appeared only after all of the lesions already were abundantly present. Cessation of Be exposure after one month had little influence on the rate of occurrence of either the accessory reactions or on the emergence of lung tumors, but focal lesions were decidedly less prevalent. (P.C.H.)

15836 DISTRIBUTION OF LABELED VITAMIN B_{12} IN RAT PLASMA AND ORGANS DURING ACUTE RADIATION SYNDROME. L. L. Shepshelevich and L. S. Rogacheva (Central Inst. of Hematology and Blood Transfusion, Moscow). Radiobiologiya, 2: 843-6(1962). (In Russian)

Distribution of Co^{60}-labeled vitamin B_{12} in plasma and rat organs was studied during acute radiation sickness induced by 500 and 700 r. Experiments indicate normal intermediate metabolism of labeled vitamins. (R.V.J.)

15837 STUDIES OF BLOOD COAGULATING SYSTEM IN IRRADIATED ANIMALS AFTER BONE MARROW TRANSPLANTATION. N. Ya. Lagutina (Moscow Inst. of Hematology and Blood Transfusion). Radiobiologiya, 2: 855-8(1962). (In Russian)

Effects of homologous bone marrow transplantation on blood coagulant indices were studied using 14 dogs suffering from acute radiation injuries. The experiments confirmed the protective effects of transplantations, preventing hemorrhages and reducing heparin and serotonin activity. (R.V.J.)

15838 DISTURBANCE AND RESTORATION OF GASTROINTESTINAL TRACT DURING EXPERIMENTAL RADIATION SICKNESS. M. F. Nesterin and K. V. Smirnov (Inst. of Nutrition, Academy of Medical Sciences, USSR and Inst. of Biological Physics, Moscow). Radiobiologiya, 2: 859-67(1962). (In Russian)

Experimentally induced radiation sickness in dogs indicated more pronounced disturbances in the secretory function of intestines than in the gastric and subgastric glands. Motor function disturbances in the small intestine are due to changes in the acetylcholine-cholinesterase system. (R.V.J.)

15839 HOMOLOGOUS BONE MARROW CHIMERAS OF GUINEA PIGS. D. R. Kaulen, K. A. Lebedev, and D. V. Stefani (Gamalei Inst. of Epidermology and Microbiology, Moscow). Radiobiologiya, 2: 873-7(1962). (In Russian)

Intravenous injections of homologous bone marrow into lethally irradiated (600 to 650 r) guinea pigs protected 46% of the animals from death during 30 days. Intraosseous injections showed no advantages over intravenous. The guinea pig chimeras exhibited no secondary stages of radiation sickness and no increase in remote death. (R.V.J.)

15840 ECG-ANALYSIS OF RESPONSES TO ADRENALINE IN DOGS RECOVERING FROM ACUTE RADIATION SICKNESS INDUCED BY WHOLE-BODY X IRRADIATION. V. I. Korchemkin and N. V. Raeva. Radiobiologiya, 2: 883-90(1962). (In Russian)

Electrocardiograms of dogs recovering from acute radiation sickness exhibited delayed cardiac functional disturbances expressed by slowed arterioventricular orifice, electric systole and ventricular extrasystole functions, and deformation and shift of time intervals. All dogs exhibited an increased sensitivity and toxicity to adrenaline. An increased stimulation of sympathetic nerve was observed in dogs suffering from a single exposure and of the vagus nerve in the dogs exposed twice. A delayed partial cardiac recovery was observed in dogs that survived a single exposure. (R.V.J.)

15841 CHEMICAL PROPHYLAXIS OF RADIATION DAMAGE IN VARIOUS ANIMALS. V. P. Korotkova and A. M. Stashkov (Inst. of Experimental Medicine, Leningrad). Radiobiologiya, 2: 903-6(1962). (In Russian)

Pathogenesis of chemical therapy and prophylaxis in radiation sickness of dogs, rabbits, rats, and white mice was evaluated. A progressive diminishing and disappearance of prophylactic efficiency of administered cysteamine, mercamine, unitiol, phenatine, antiphenatine, ethyl-, and allyl-

norantiphein in animals exposed to lethal doses discourage efficient chemical prophylaxis. (R.V.J.)

15842 RADIATION PROTECTION IN VITRO WITH INDOLE SERIES AND OTHER COMPOUNDS. P. G. Zherebchenko. Radiobiologiya, 2: 912-18(1962). (In Russian)

It is shown that indole, indole amine and indole butyric acid are effective in protecting 5-aminomethyl uracil against irradiation. The protective effects of indole in vitro are related to the indole ring reaction with aqueous radiolysis products and do not correlate with the protective effects in vivo. Investigations of the mercapto group indicated the effective protective ability of unitiol and indole derivatives, weaker effectiveness of mercamine, and much weaker effectiveness of histamine. The protective ability of the mercapto group in vitro is related mostly to the free SH group and does not disappear in groups lacking NH_2. (R.V.J.)

15843 INCORPORATION OF S^{35} METHIONINE IN THE BONE MARROW AND SPLEEN PROTEIN IN ACUTE RADIATION SICKNESS AND EFFECTS OF BONE MARROW TRANSPLANTATION ON THE PROCESS. V. A. Revis (Kalinin Medical Inst., USSR). Radiobiologiya, 2: 919-25 (1962). (In Russian)

Protein metabolism in rabbit bone marrow was traced at various stages starting with the moment of exposure to 1100 r and continuing through the recuperating and hematological normalization points. A sharp drop in S^{35}-labeled methionine incorporation in the bone marrow, spleen, and skeletal muscle was observed during acute stages. A maximum drop in protein synthesis (0.1 to 0.02% as compared to 4.5, 3.2, and 0.8% in control animals) was observed within 2 weeks of the exposure. The intensity of methionine uptake was restored and even increased to normal (10.6 and 5.5%) two months following the exposure. Therapeutic bone marrow transplantation in rabbits prevents the sharp drop in S^{35}-methionine uptake. (R.V.J.)

15844 PATHOLOGICAL-PHYSIOLOGICAL INVESTIGATION OF SOME PECULIARITIES OF RADIATION INJURIES AND OF CHEMICAL PROTECTION OF INTACT AND SYMPATHECTOMIZED ANIMALS. S. J. Arbusow, A. M. Staschkow, and W. P. Korotkowa (Inst. for Experimental Medicine, Moscow). Strahlentherapie, 120: 87-97 (Jan. 1963). (In German)

The action currents of the cerebral cortex and the hypothalamus, after whole-body irradiation with 1000 R, and the effect of a prior resection of the cervical sympathetics and the administration of radiation protection substances were encephalographically investigated on rabbits. There was an increased depression of the action currents of the central nervous system and an increased sensitivity of the total organism to the irradiation during the first period after the sympathectomy with decreased effect of the radiation protection substances. However, irradiation 30 to 60 days after the sympathectomy showed a recovery from the damage, which appears partly as an increased radiation resistance. (auth)

15845 TECHNIQUES OF OBTAINING AND PREPARING SUSPENSIONS OF SPLEEN AND BONE MARROW FOR THE TREATMENT OF SUPRALETHALLY IRRADIATED DOGS. Jerrold K. Longerbeam, Richard C. Lillehei, Edmund Yunis, and Sadek Hilal (Univ. of Minnesota, Minneapolis). Surgery, 50: 274-87(July 1961).

Techniques were developed to obtain and process splenic and bone marrow cell suspensions with large yields of viable cells, up to 22×10^9 viable spleen cells and 20×10^9 viable bone marrow cells. The techniques are uncomplicated and require a minimum of equipment. Any balanced salt solutions suitable for tissue culture work, to which antibiotics and anticoagulants have been added in the concentrations described, are satisfactory suspending solutions. Careful adjustment of the pH of the suspending solution to 7.2 and cooling of the suspension to 4°C during the entire in vitro period increases viability of the cells. Preparations of autologous spleen and bone marrow cells protected dogs maintained in standard laboratory conditions and given lethal or supralethal whole-body irradiation. The degree of protection afforded appears to be approximately proportional to the total number of viable cells given. For a given number of cells, bone marrow cells appear to be slightly more protective than spleen cells, especially at the higher levels of irradiation. (P.C.H.)

15846 RADIOLÉSIONS RADIOCANCERS ET RADIOPROTECTION CHIMIQUE. (Radiation Lesions, Radiation Cancers, and Chemical Radiation Protection). D. J. Mewissen. Brussels, Editions Arscia and Paris, Librairie Maloine, 1961. 289p.

Operational concepts based on biometrical ideas which more nearly resemble those used in the physical sciences are considered for use in radiobiology. The distributional method for evaluating blood cell counts is described. By this method the fate of survivor mice following whole-body irradiation is anticipated much more exactly. A biometrical treatment, called the marking probit, was developed for studying the mechanism underlying leukemogenesis in whole-body irradiated mice. It is shown by this method that more than one critical event contributes to the development of mouse leukemia. Another conclusion suggested by the marking probit analysis is that there is no actual threshold for leukemogenesis. Extensive use was made of the Gompertzian method for studying the late effects of whole-body irradiation of mice. No difference was observed in the slope of the survival curves of the mice treated with cysteamine, cystamine, streptomycin, or physiological saline. There was, however, a shift in the cause of death, with an increased leukemia incidence among those chemically protected and a similar incidence of other fatal diseases. (M.C.G.)

15847 RADIATION EFFECTS OF BONE-SEEKING RADIONUCLIDES AS DETERMINED BY HISTOPATHOLOGICAL AND HISTOCHEMICAL STUDIES OF SWINE BONE. William James Clarke. Thesis, Pullman, Wash., Washington State Univ., 1962. 191p.

Miniature swine were injected intravenously with either Sr^{90}, Ra^{226}, or Pu^{239} at 6 weeks, 6 months, or one year of age to compare the relative toxicity of these radionuclides per se, and to assess the effect of age on the appearance and type of pathological lesions. Cellular and biochemical constituents of the blood, and x rays of representative bones were examined periodically during the course of the experiment. At autopsy, samples of rib bone were taken for radioanalysis and histopathological and histochemical examination. Significant findings are reported. It was concluded that Pu^{239} in swine, irrespective of age, is more damaging per rad than Ra^{226} or Sr^{90}. (M.P.G.)

15848 IMMUNOLOGIYA OSTROGO LUCHEVOGO PORAZHENIYA. (Immunology in Acute Radiation Sickness). R. V. Petrov. Moscow, Gosatomizdat, 1962. 267p.

A survey is given of radiation effects on antimicrobic immunity in animals and infectious complications and noninfectious immunity in radiation sickness. Radiation changes induced in antigen tissue, the part played by tissue antigens in radiation injury pathogenesis, and the development of immunology by c reactive protein and tissue transplantation are analyzed. (R.V.J.)

CHEMISTRY

General and Miscellaneous

Refer also to abstract 16234.

15849 (CRCE-1131) USE OF ATTAPULGUS CLAY FOR ORGANIC COOLANT PURIFICATION. J. J. Duerksen and D. H. Charlesworth (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1963. 19p. (AECL-1683)

Tests were conducted using Attapulgus to demonstrate that good impurities removal was possible at high flow rates, that the capacity of the clay was sufficient, and that a suitable column design could be achieved. Data are included which lead to the conclusion that this clay is suitable for use in large-scale power reactors. (J.R.D.)

15850 (ORNL-3397) ANALYTICAL CHEMISTRY DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1962. (Oak Ridge National Lab., Tenn.). Feb. 8, 1963. Contract W-7405-eng-26. 171p.

The report is divided into 4 major parts with several sections in each part. Separate abstracts were prepared for all sections in Parts I and II except 8 and 9 (containing information on mass spectrometry and microscopy). A summary of service analyses is given in Part III, and information concerning the ORNL master analytical manual is presented in Part IV; abstracts were not prepared for these. (J.R.D.)

15851 (ORNL-3397(p.1-16)) ANALYTICAL INSTRUMENTATION. M. T. Kelley and D. J. Fisher (Oak Ridge National Lab., Tenn.).

Evaluation of the direct-readout circuits for the ORNL model Q-2005 controlled-potential coulometric titrator showed that the precision and accuracy of the direct readout are entirely satisfactory and are as good as those obtained with manual readout. New modifications of the original Q-2005 circuit were designed for special applications. With low-resistance cells, a new transistor current amplifier, used in place of the original, will deliver up to 3 amp. For high-resistance cells, a second modification eliminates the transistor current amplifier, and the GAP/R USA-3 potential-control amplifier delivers to the cell as much as ±8 ma at ±100 v. In a third modification, a complementary-pair emitter follower stage can supply either anodic or cathodic current without the necessity of switching the titrator from "oxidize" to "reduce." A high-sensitivity controlled-potential (or constant-current) coulometric titrator was designed, fabricated, evaluated, and put into service. The upper limits of the ranges for full output of the integrating amplifier are 1, 10, 50, and 100 μeq of substance titrated. Fabrication and maintenance instructions for the indicated models of the following ORNL instruments were brought up to date: coulometric titrators Q-2005 and Q-2005-X50; fluorophotometer Q-1165; flame spectrophotometers Q-1457 and Q-1887; the remotely operated filter photometer Q-1734; and the controlled-potential and derivative polarograph Q-1988A. Safety devices were assembled and installed on the high-vacuum systems of three vacuum-fusion apparatuses. The devices automatically prevent damage that would otherwise result from unscheduled interruptions or failures of line power. A sample-cutting jig was designed and built for use in precisely taking successive samples from graphite bars. The samples are used in the measurement of diffusion of U into the bars. Features added to a high-sensitivity, direct-reading, linear, recording conductivity titrator include a circuit to compensate for changes in solution temperature; and a circuit to compensate for the initial conductance of the solution, so that subsequent conductivity changes can be measured on a scale that is 100 times as sensitive as that which could be used otherwise. With the latter compensator, which is to be used with thermostated cells, full-scale readings can be obtained for small changes (e.g., 0.01 ohm per ohm). Electrical tests indicate an error of ±1% for conductances between 1 μmho and 0.5 mho; linearity is achieved to within ±0.1%. It is planned to evaluate the performance of this instrument in several applications. A direct-reading spectrophotometer was designed and built for use in the determination of Be. The electronic portion of the instrument performs satisfactorily, but the optical section is being improved. An operational amplifier was used as an impedance-transforming current amplifier between a multiplier phototube and an unmodified recorder. This technique was used to make possible the replacement of a recorder in a scanning flame spectrophotometer by one of faster response. A new single-beam flame spectrophotometer, designated model VI, was designed and built and is in use. Its circuit has improvements over that of the model Q-1887. Apparatus and instruments were provided that make possible the remotely controlled analysis of radioactive samples. A filter photometer was fabricated for use in the MSRE Hot-Cell Mock-Up. An improved absorption-cell attachment for the Welch Densichron reflectance unit was designed and built for the Radioisotopes-Radiochemistry Laboratory. A new decapper-pipetter assembly, which includes a decapper having a novel clamping arrangement, was designed; the prototype was fabricated for the Radioisotopes-Radiochemistry Laboratory. A Cu capsule was designed for use in the preparation of frozen MSRE salt samples; the sample must be broken free of a ladle, pulverized, mixed, and transferred to a sample bottle. Results of tests of the performance of the capsule have been satisfactory. An apparatus is being designed for remotely opening the sample-transfer tube and removing the ladle that contains the MSRE samples. Several developments in polarography were made. The design of the circuitry of the a-c controlled-potential polarography was improved. In d-c polarography, a study was made with the ORNL model Q-1988-ES controlled-potential and derivative polarograph of the relative sensitivity obtained (without resort to preconcentration) with various types of Hg cathodes, including a pool with quiet and with stirred solution and the following variations of a D.M.E.: unmodified and drawn-out "2-5 sec" and unmodified "6-12 sec" Sargent capillaries, Atlas-Werke siliconed capillaries, two varieties of bulb-type capillaries, capillaries having mechanically controlled drop time, and Smoler vertical-orifice capillaries. Because the Q-1988-ES polarograph has high current-measuring sensitivity, no advantage accrued from the use of a Hg pool rather than a D.M.E. Of the D.M.E.'s tested, highest sensitivity was achieved with a small-orifice D.M.E. and with a Smoler 0.5-sec vertical-orifice D.M.E. The use of a 0.5-sec rather than a 5-sec D.M.E. makes it possible to increase the speed of response of the current-averaging and derivative computers, so that the scan rate can be increased about tenfold without adverse effect on

the form of the recorded waves. It was learned that polarograms made with a Smoler 0.5-sec vertical-orifice D.M.E. do not have maxima of the second kind, are very reproducible, and are of conventional form. Short drop times and good polarograms were also obtained with a conventional D.M.E. by mechanical control of the drop detachment, but this method requires considerable additional equipment. With the circuit modifications made possible by use of the 0.5-sec drop time, at a scan rate of up to about 300 mv/min, regular and first-derivative polarograms for simple, reversible, diffusion-controlled processes have the theoretical form unaffected by instrument characteristics. Use of scan rates no faster than 300 mv/min is particularly advantageous in obtaining maximum resolution of closely adjacent waves; in determining reversibility, diffusion control, or n values; and in measuring $E_{\frac{1}{4}}$ values. At a scan rate of 3000 mv/min, time lag is appreciable; however, for concentration measurement with resolved waves, this is not deleterious, and the polarogram is recorded in about 6 sec. The significant gain in resolution and sensitivity of first-derivative polarography over regular polarography indicated that the feasibility and utility of second-derivative polarography should be investigated. An equation was derived that describes the form of a second-derivative polarogram for simple, reversible, diffusion-controlled processes; the height of the two peaks of equal height is directly proportional to i_d, n^2, and the square of the scan rate. Although the resolution of second-derivative polarography is greater than that of first-derivative polarography, the range of concentration ratios over which a peak in each of the second-derivative polarograms of close $E_{\frac{1}{4}}$ values would be resolved and the corresponding first-derivative polarograms would overlap is rather restricted. A second-derivative computer was designed and tested. With a drop time of about 4 sec and a scan rate of 100 mv/min, the sensitivity of second-derivative polarography was not as good as that of first-derivative polarography because of the high level of noise. With a 0.5-sec D.M.E., the new computing circuits, and scan rates of the order of 3000 mv/min, the noise problem is greatly reduced. Work is being continued on second-derivative polarography as a method of obtaining high sensitivity. An equation was derived for the third derivative of the average d-c polarographic current with respect to time for a simple, reversible, diffusion-controlled process. The results of comparisons of plots of the theoretical forms of regular and of first-, second-, and third-derivative polarograms indicated that there is no apparent analytical advantage to be gained from third-derivative polarography. (auth)

15852 (ORNL-3397(p.17-24)) CHEMICAL ANALYSIS OF ADVANCED REACTOR FUELS. J. C. White and P. F. Thomason (Oak Ridge National Lab., Tenn.).

The development of methods for the analysis of dissolver solutions has continued, the major effort being directed toward the controlled-potential coulometric titration of U following its separation from major components of the dissolved fuel. A method for determining U that consists in the extraction of U into a cyclohexane solution of tri-n-octylphosphine oxide, back-extraction, and coulometric titration at controlled-potential was developed. This method was evaluated by analyzing synthetic dissolver solutions that were made to represent seven different reactor fuels. Two controlled-potential coulometric titration methods for the determination of U^{4+} in U–Nb alloys were developed. Sodium tripolyphosphate was studied as an electrolyte for the controlled-potential coulometric titration of U. It was found that both U^{4+} and U^{6+} can be determined in this medium. The polarographic studies with the Teflon dropping-mercury electrode for use in glass-corroding media have continued; two papers and an ORNL topical report that describe this work were published. (auth)

15853 (ORNL-3397(p.24-6)) ANALYSIS OF MOLTEN SALTS BY ELECTROCHEMICAL METHODS. J. C. White and D. L. Manning (Oak Ridge National Lab., Tenn.).

The emf method for the evaluation of association constants for metal complexes in molten nitrate salts was extended to include silver cyanide and lead bromide. The voltammetry of silver in $NaNO_3$–KNO_3 at 246 to 326°C was investigated as the initial step in the general program on molten-fluoride-salt voltammetry. The use of a three-electrode system with a quasi-reference electrode is contemplated. (auth)

15854 (ORNL-3397(p.26-38)) SPECIAL RESEARCH PROBLEMS. J. C. White and P. F. Thomason (Oak Ridge National Lab., Tenn.).

Absorption spectrophotometric studies of Pu were continued to determine the kinetics of the polymerization and depolymerization of Pu^{4+} in nitrate solutions and to determine the properties of the polymer with respect to such parameters as acidity, temperature, and ionic concentration. Design modification of a high-temperature high-pressure spectrophotometer was continued. The spectrophotometer is to be operable with highly radioactive solutions at temperatures of the order of 330°C and at pressures as high as 5000 psi. An automatic, digital, data-output system for recording absorbance data was installed on the Cary model 14 CMR spectrophotometer. This instrument is being used in connection with a miniature circulating loop. Spectral studies are to be made with this instrument on systems that will be investigated later on the high-temperature high-pressure spectrophotometer. A method was devised for measuring densities of aqueous solutions at high temperatures and high pressures by use of x-ray photographs to show the position of the vapor-liquid interface in a calibrated section of an autoclave. Spectrophotometric studies were continued on molten-fluoride-salt systems. Causes of solution instability, primarily hydrolysis, were ascertained and corrected. A captive-liquid cell was perfected to contain the corrosive molten fluorides. This cell, which holds the liquid in the plane of the light beam by means of surface tension effects, provides a convex lens shape and thereby promotes improved light transmission. The absorption spectrum of UF_3 in NaF–LiF–KF was recorded for the first time. The absorption peaks occur at 890 (strong), 975, and 1060 mμ. Studies on the absorption spectrum of NdF_3 in NaF–LiF–KF were continued. Several volumetric titrations were evaluated with respect to accuracy and precision by means of microchemical techniques. (auth)

15855 (ORNL-3397(p.38-54)) GAS-COOLED REACTOR PROJECT ANALYSES. J. C. White and A. S. Meyer (Oak Ridge National Lab., Tenn.).

Development of instrumental methods of analysis for the He (blanket gas) of the Gas-Cooled Reactor, Molten-Salt Reactor, and Pebble-Bed Reactor included the improvement of a process chromatograph for the measurement of ppm concentrations of impurities in He, the design and installation of a process chromatograph for the determination of impurities in radioactive He streams, and the evaluation of an electrolytic O_2 analyzer. Modifications to laboratory chromatographs included the installation of dual

columns to a Perkin-Elmer chromatograph to provide increased versatility and improved sensitivity in the analysis of samples at low pressures, the adaptation of a Burrell chromatograph for use in studies of the rate of reactions of graphite, and the improvement of the sensitivity of a chromatograph used for the analysis of gases from organic moderators. Techniques were devised for the purification and concentration of fission gases from charcoal traps and for the trapping of carbon tetrafluoride together with Kr and Xe from MSRE capsule tests to effect concentration of these gases for subsequent analysis by chromatographic or mass spectrographic techniques. Assistance was given in engineering investigations to evaluate techniques of purification of He and to determine potential contamination of He from the high-temperature desorption of gases from thermal and electrical insulating materials. Additional hydrocarbons, principally olefins, in the gases evolved on dissolution of uranium carbides in water were identified and determined by chemical separations and gas chromatographic techniques. A chromatographic column assembly was fabricated for the analysis of radioactive gases evolved during the dissolution of neutron-irradiated samples of uranium carbides. A Teflon-and-glass sampling system was developed for the chromatography of corrosive gases. A combustion method for the determination of traces of residual carbonaceous material that remains in solution after the dissolution of metallic carbides was adapted for the analysis of nitric acid solutions. The $KBrF_4$ procedure for the determination of O_2 in fluoride salts was modified to reduce the contribution of the blank in the determination of ppm concentrations. The modified procedure was also applied to determine O_2 and N_2 in metallic Li. A proposed C-reduction method for O_2 is being evaluated by comparison with the $KBrF_4$ procedure. A modified amalgamation method was found to give precise results in the determination of ppm concentrations of O_2 in K. Standard-addition tests to establish the accuracy of the procedure are in progress. A highly sensitive method based on separation by amalgamation and final determination of H_2 by gas chromatography was developed for the determination of hydrides in alkali metals and NaK. The method has also been applied to the determination of reactive metals in salts. (auth)

15856 (ORNL-3397(p.54-6)) EFFECTS OF RADIATION ON ANALYTICAL METHODS. J. C. White (Oak Ridge National Lab., Tenn.).

The effect of gamma radiation on the colorimetric determination of Cr with 1,5-diphenylcarbohydrazide was studied. Levels of gamma radiation < 1000 r were found to cause little error in the method. The effect of gamma radiation on ethylenediaminetetraacetic acid was also studied. It is destroyed to the extent of $\sim 1 \times 10^{-9}$ mmole per ml of EDTA solution per roentgen. A study was initiated of the effects of gamma radiation on the thiocyanate–stannous chloride spectrophotometric method for the determination of Mo. Effects of gamma radiation on Mo^{6+} and thiocyanate ions in aqueous solutions were measured. A pyrolytic graphite electrode, which offers considerable promise for applications to radioactive solutions, was found suitable as an indicator electrode for acid-base and redox titrations and in the voltammetric determination of various metallic ions. (auth)

15857 (ORNL-3397(p.57-70)) X-RAY AND SPECTROCHEMICAL ANALYSES. (Oak Ridge National Lab., Tenn.).

Techniques were developed for performing quantitative local microanalysis with the x-ray fluorescence microprobe when known standard alloys are not available. The technique was applied to superconducting Zr–Nb alloys and other specimens. A computer code (IBM 7090) was written to calculate best-fitting parameters for the determination of a given element by x-ray absorption-edge analysis. A second code was written to use these parameters to calculate the chemical concentration of the element in any sample. An absorption tube was built to be used with a Beckman burner in atomic absorption analysis. This tube gives superior performance in the detection of Hg. The demountable hollow cathode was found to be an inexpensive and versatile light source for determining Pb, Zn, Cd, Ni, and Mg by this method. Fluorine as CF_4 was detected at the 10-ppm level in He by use of the hollow cathode. A procedure was developed for collecting Cs at the 10^{-10}-g/ml level from water, or at the 10^{-7}-g/g level from solids, and determining the Cs by flame photometry. The Cs content of the U. S. Geological Survey granite G-1 was measured. The accuracy of Quantometric determinations of trace elements in human-tissue ash was checked by independent methods of analysis and was found to be satisfactory. The scope of analysis was extended to bone ash. Losses of trace elements during the ashing process (at 450°C) were found to be less than 20% for elements not known to be volatile. A 21-ft Wadsworthmount spectrograph was converted for the direct spectrometric determination of O_2 in metals and salts. Oxygen can be determined in steels in ~5 min. The variability of the Baird direct reader-computer system was determined statistically over its entire working range. The relative standard error at the 95% confidence level was less than ± 0.5% for the overall system. Varying the concentrations of several elements was found to have no effect on the ratio of the intensities of several rare-earth metals to the intensity of Sr. A d-c-arc method was developed for determining Ta/Nb ratios in mixtures of tantalum oxides and niobium oxides. (auth)

15858 (ORNL-3397(p.71-112)) NUCLEAR AND RADIOCHEMICAL ANALYSES. J. C. White and W. S. Lyon (Oak Ridge National Lab., Tenn.).

Properties of dialkyl phosphorodithioic acids were studied in several extraction systems. The solvent-extraction behavior of metal di-n-butyl phosphorodithioates and the use of di-n-butyl phosphorothioic acid as a metal-ion extractant were investigated. Tetraphenylarsonium chloride was used as an extractant for fluoanions. The valence states of five ORNL radioisotope products were determined. A method was developed for separating Se from Te by solvent extraction. The separation and determination of Am in solutions that contained transuranium elements was demonstrated. Radioisotopes have been applied in a radiotracer method for fluoride (Ta^{182}), in methods for the alkaline-earth elements (Ca^{47}, Sr^{89}, and Ba^{133}), in a gamma-neutron method for Be (Sb^{124}), and in determination of the surface areas of UO_2 and CaF_2 (U^{237} and Ca^{45}). Work has continued on identification of radioactivities in the ORR pressurized water loop. The decay scheme of Au^{199}, isomer formation and separation in Te isotopes, and properties of nuclear levels in odd-A nuclei were studied. Three proposed new radioisotope products, K^{43}, Br^{77}, and I^{129}, were examined. Electronic stripping and computer techniques have been applied to gamma-ray spectrometry. Radioactive gases were determined by conventional gamma-ray spectrometry, and a high-level system was used for hot reactor loop studies. In addition, a number of special irradiated reactor materials (fused salt, graphite, and Zircaloy-2) were studied by gamma-ray spectrometry. A 150-kv Cockcroft-Walton

neutron generator was installed and used for a number of purposes, including the determination of O_2. Eight Am^{241} (0.6 g)–Be(6 g) sources were fabricated and used for rapid soil and metals analyses. A number of special samples were analyzed for particle-size distribution. Neutron-activation methods were evaluated for interferences such as high-cross-section contaminants. Methods have been developed for the comprehensive activation analysis of Be and Al matrices for as many as 67 elements. Backflow-prevention systems and the flow of water through turbines were studied by addition of stable isotopes and later use of activation analysis for determination. Activation methods for S in a number of materials, including a flux-monitoring system using CS_2, were developed. Delayed-neutron counting for U^{235} was applied to samples in which the U^{235} content ranged from 10 to 10^4 $\mu g/g$. The $Li^6(n,\alpha)t$ and $O^{16}(t,n)F^{18}$ reactions were used to determine O_2 in fused salts. The radioisotope Pa^{231} and a number of stable trace elements were determined in radioactive materials. A method for As was developed using activation and radiochemical techniques. Neutron activation was used for survey and identification purposes with a large variety of materials. Included in the studies have been auto paints, soil, soot, narcotics, drugs, containers and other materials used in the pharmaceutical industry, opium, writing inks, carbon-paper print, typewriter-ribbon inks, barbitals, and meperidine hydrochlorides. Applications to oceanography were also studied. The thermal and resonance neutron fluxes in the ORR were measured by use of Co–Al and Au–Al foils. Neutron fluxes were also measured by use of activation induced into irradiated stainless steel. Development of a glass-loaded liquid scintillator has continued, the solvent being 1-methylnaphthalene. (auth)

15859 (ORNL-3397(p.112-13)) INORGANIC PREPARATIONS. M. T. Kelley, D. E. LaValle, and R. B. Quincy, Jr. (Oak Ridge National Lab., Tenn.).

The preparation of fused salts occupied a major portion of the time. The problems connected with the preparation of iodides were solved. The work for the Physics Division was concerned almost exclusively with the preparation of alloys of the rare-earth metals and with the behavior of H_2 toward the Pd–Fe system and toward such metals as Cr and Ni. In the program for the preparation of high-purity K_2O moderate success was achieved, and the preparation of the analogous oxides of some of the other alkali metals was undertaken. High-purity MgO was prepared, and a preliminary preparation of high-purity TiO_2 was completed. The study of the chemistry of Re was resumed with the aim of producing some of the lower fluorides of this element. (auth)

15860 (ORNL-3397(p.113-16)) ORGANIC PREPARATIONS. J. C. White, P. F. Thomason, and H. L. Holsopple, Jr. (Oak Ridge National Lab., Tenn.).

A number of special organic compounds that are not available commercially were synthesized on request from other research divisions. Among these compounds were arsenazo III (a new reagent for the spectrophotometric determination of Th), n-hexylbenzene, and n-heptylbenzene. The following compounds were purified for use in special applications: diphenyl ether, diphenylcarbohydrazide, tetramethylammonium hydroxide, 1-methylnaphthalene, 1,4-dioxane, and di(2-ethyl-hexyl)phosphoric acid. (auth)

15861 (ORNL-3397(p.117-21)) IONIC ANALYSES. Hisashi Kubota (Oak Ridge National Lab., Tenn.).

A more rapid method for the determination of Th in granite was developed. Arsenazo III was synthesized and evaluated as a chromogenic reagent for the determination of Th. The amperometric EDTA titration method for the determination of Th was modified for use in a hot cell. Several highly radioactive refractory materials were dissolved by use of ammonium bifluoride fusions. For the determination of Li in BeO, perchloric acid was found to be the most suitable dissolution reagent. The use of the gas chromatograph for the determination of <10 ppm of C in high-purity steels was studied. The Leco apparatus was used to determine C in NaK. The sodium phenoxide spectrophotometric method was used to determine N_2 in NaK. A continuous amperometric titration method for the determination of Zr was developed for use in a hot cell. Acetone and pyridine were found to be suitable solvents for nonaqueous titration of phenols. The studies on the disposal of radioactive wastes in natural salt have continued in cooperation with the Health Physics Division. It was found that salt samples when heated to 260 to 300°C fracture and release steam. Quantitative measurements are in progress. (auth)

15862 (ORNL-3397(p.121-3)) INFRARED STUDIES. C. A. Horton (Oak Ridge National Lab., Tenn.).

The application of infrared spectrometry to analytical problems increased markedly. Unknown organic compounds were identified by functional groups, and changes in structure due to radiation damage and/or chelation were studied. Some infrared spectral studies were made on potassium pertechnetate, potassium permanganate, and potassium perrhenate. Lithium fluoride crystals were examined for the presence of hydroxyl groups. (auth)

15863 THE GEOMETRIC FACTOR OF CATALYSTS IN THE ISOTOPIC EXCHANGE REACTION OF PARAXYLENE WITH DEUTERIUM OXIDE. Kozo Hirota and Tomiko Ueda (Osaka Univ.). Bull. Chem. Soc. Japan, 35: 1900-1(Nov. 1962). (In English)

The geometric factor in catalysis was investigated using the isotopic exchange reaction of p-xylene with D_2O and a large number of metallic catalysts. The results, plotted on a ratio of ring hydrogen exchange to methyl hydrogen exchange vs lattice constant graph, shows a monotonic curve. (D.L.C.)

15864 NATURE AND PRODUCTION OF SOME ACTIVE FORMS OF HYDROGEN AT VERY LOW TEMPERATURE. Bernard Dreyfus, Jacques Mercier, and Louis Weil (Centre de Recherches sur les Très Basses Temperatures, Grenoble, France). Compt. Rend., 256: 93-5(Jan. 2, 1963). (In French)

The active centers formed during deposition on a liquid-helium cooled surface of hydrogen and deuterium plasma accelerated under low voltage was studied by electron paramagnetic resonance. The effect of the nature of the support (H_2 and D_2) was determined. The active species seem to correspond to molecules of the support and not to the active species of the plasma. (tr-auth)

15865 HIGH-TEMPERATURE ION EXCHANGE PROPERTIES OF ZIRCONIUM PHOSPHATE. J. R. Grover and B. E. Chidley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Ind. Chemist, 39: 31-7(Jan. 1963).

The preparation and testing of a 15-kg batch of granular zirconium phosphate is described. A series of ion exchange runs at temperatures from 180 to 300°C was made which indicated the effect of temperature, solution pH and flow-rate, and particle size of the exchanger. (auth)

15866 RADIATION-RESISTANT LUBRICANTS AND THEIR USE. Peter Michael Blanchard and Neville John Hunter (to British Petroleum Co., Ltd.). British Patent 920,735. Mar. 13, 1963. Filed Jan. 29, 1960.

A method is given for preparing radiation-resistant lubricants. The method comprises reacting a halogenated paraffin with 5 to 7 times the theoretical amount of an aromatic compound required to react with all the halogen, in the presence of a Friedel-Craft catalyst. The paraffin should have 12 to 30 carbon atoms and contain 15 to 50 wt % halogen, and the aromatic compound should have the formula $C_6H_{6-n}R_n$, where n = 0 to 5 and R = an alkyl group of 1 to 5 carbon atoms. After its preparation, the lubricant should be thickened to grease consistency with a nonsoap thickening agent. (D.L.C.)

15867 ELECTRODIALYTIC TREATMENT OF WATER CONTAMINATED BY RADIOACTIVE SUBSTANCES. Thomas Victor Arden (to Permutit Co., Ltd.). British Patent 920,862. Mar. 13, 1963. Filed Jan. 11, 1961.

A process is given for the treatment of contaminated water so that it may be safely discharged to rivers or sewers. The process comprises a first electrodialytic treatment using conventional apparatus, addition of salt to the water, and finally a second electrodialytic treatment using compartments filled with a mixture of cation- and anion-exchange materials. The salt addition raises the content of total dissolved solids and reduces polarization in the second treatment. An overall decontamination factor of 10,000 is obtainable with this process, and higher factors can be obtained using further treatments and adding salt to reduce the polarization. (D.L.C.)

15868 PROCESS FOR REMOVAL OF RADIOACTIVE CONTAMINANTS FROM SURFACES. Kenneth Walter Newman (to Purex Corp., Ltd.). U. S. Patent 3,080,262. Mar. 5, 1963. Filed Apr. 7, 1959.

A process is given for removing radioactive contaminants from the internal surface of loop piping of a nuclear power plant, together with both tight and loosely adherent scale. The process comprises contacting the surface in succession with three solutions. The first solution contains an alkali, an alkanolamine, and a complexing agent; the second solution, an alkali, a permanganate, and an alkali metal fluoride; and the third solution, an aqueous nitric acid solution. (D.L.C.)

15869 COMPOSITION FOR RADIOACTIVE DECONTAMINATION AND DESCALING OF COBALT ALLOYS. Kenneth Walter Newman (to Purex Corp., Ltd.). U. S. Patent 3,080,323. Mar. 5, 1963. Filed Apr. 7, 1959.

The alkaline permanganate solution used in the process of U. S. Patent 3,080,262 to decontaminate internal surfaces in a nuclear power plant, is corrosive to cobalt alloys, particularly Stellite 6 and Stellite 12. The permanganate solution may be made noncorrosive to cobalt alloys by the addition of a soluble chromate. Several examples of such noncorrosive permanganate solutions and their use are given. (D.L.C.)

15870 METHOD FOR PREPARING AMIDES OF POTASSIUM, RUBIDIUM, OR CESIUM. Bernard Lefrancois and Gérard Lepoutre (to Houilleres du Bassin du Nord and Commissariat a l'Energie Atomique). U. S. Patent 3,082,158. Mar. 19, 1963. Priority date July 22, 1959, France.

A method is given for preparing ammonical solutions of alkali metal amides by electrolysis of alkali metal salts in ammonia. The electrolysis is carried out at high current densities (>0.1 amp/cm^2) without the occurrence of short circuits by means of high temperatures (10 to 30°C). The concentration of the alkali metal salt in ammonia should be at least 100 g/l. An electrolytic cell for carrying out the method is described. (D.L.C.)

Analytical Procedures

Refer also to abstracts 16561 and 16894.

15871 (AEET/HP/TM-10) ESTIMATION OF TRITIUM BY GAS-PHASE COUNTING TECHNIQUE. S. D. Soman, T. S. Iyengar, S. H. Sadarangani, and P. K. Vaze (India. Atomic Energy Establishment, Trombay). 40p.

The construction, operation, and standardization details of a gas-phase counting system employed for the estimation of T in aqueous samples are described. Two different methods were employed for the extraction of a suitable gas for internal counting in a G-M counter. The counter characteristics and calibration details are established independently with hydrogen and acetylene. The former is produced by reducing the test sample with Ca, while the latter is prepared by treating the test sample with CaC_2, both reactions taking place at room temperature. The counter uses Burshane as the quenching gas in the hydrogen method. Quenching gas is not necessary in the case of acetylene filling. The lower limits of tritium concentration satisfactorily assayed are 2×10^{-4} μC/cc and 2×10^{-3} μC/cc in acetylene and hydrogen methods, respectively. The build-up of T concentration in CIR moderator and the method of computation of atmospheric T levels are discussed. (auth)

15872 (AERE-R-4216) A SEMI-MICRO VACUUM FUSION APPARATUS FOR THE DETERMINATION OF OXYGEN IN URANIUM AND PLUTONIUM CARBIDES. B. L. Taylor and H. A. Prior (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Feb. 1963. 17p.

A semi-micro vacuum fusion apparatus, constructed primarily for oxygen determinations in UC, PuC, and UC/PuC is described. Measures taken to contain activity and to minimize oxygen contamination of the sample are discussed. Details of the measurement of the accuracy and precision of the method are given and attention is drawn to certain problems that arise in the determination of oxygen in PuC, UC, and UC/PuC. (auth)

15873 (AERE-R-4218) TABLES FOR THE CORRECTION OF X-RAY LINE BREADTHS AND PEAK HEIGHT FOR $\alpha_1 \alpha_2$ DOUBLING EFFECTS. M. Bowler and I. F. Ferguson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1963. 13p.

Results relating the observed integral and half breadths of an x-ray reflection to the true integral and half breadths corrected for $\alpha_1 \alpha_2$ doubling are presented. The variation of observed peak line height with degree of $\alpha_1 \alpha_2$ doublet separation is also given. The results apply to line profiles represented by the functions: $y = 1/(1 + x^2) + 1/2\{1 + (x + a)^2\}$, $y = \exp(-x^2) + \frac{1}{2}[\exp\{-(x + a)^2\}]$, and $y = 1/(1 + x^2)^2 + 1/2\{1 + (x + a)^2\}^2$. (auth)

15874 (CEA-2226) ANALYSE QUANTITATIVE DES PRODUITS DE FISSION PAR SPECTROGRAPHIE γ. (Quantitative Analysis of Fission Products by γ-Spectrography). Georges Malet (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1962. 66p.

The activity of the fission products present in treated solutions of irradiated fuels is given as a function of the time of cooling and of the irradiation time. The variation of the ratio (Ce^{144} + Pr^{144} activity)/(Cs^{137} activity) as a function of these same parameters is also given. From these results a method is deduced giving the "age" of the

solution analyzed. By γ-scintillation spectrography it was possible to estimate the following elements individually: Ce^{141}, $Ce^{144} + Pr^{144}$, Ru^{103}, $Ru^{106} + Rh^{106}$, Cs^{137}, $Zr^{95} + Nb^{95}$. Yield curves are given for the case of a single emitter. Of the various existing methods, that of the least squares was used for the quantitative analysis of the fission products. The accuracy attained varies from 3 to 10%. (auth)

15875 (HW-76363) AN ANALYSIS FOR FREE NITRIC ACID AND TOTAL NITRATE ION IN URANYL NITRATE AND PLUTONIUM NITRATE SOLUTIONS USING A CATION EXCHANGE RESIN. M. H. Campbell and J. F. Adams (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 6, 1963. Contract AT(45-1)-1350. 12p.

The determinations can be made in a single operation using a caustic titration after the cation exchange separation. The analysis takes less than one hr elapsed time. Procedures are given along with experimental results. (J.R.D.)

15876 (LA-2844) THE SPECTROPHOTOMETRIC DETERMINATION OF URANIUM IN MIXTURES OF URANIUM AND TUNGSTEN. A. D. Hues and A. L. Henicksman (Los Alamos Scientific Lab., N. Mex.). Nov. 1962. Contract W-7405-eng-36. 10p.

Uranium is determined in mixtures of U and W, using 3-(2-arsonophenylazo)-4,5-dihydroxy-2,7-naphthalenedisulfonic acid (arsenazo) as the chromogenic agent. The colored complex is developed by the addition of arsenazo to aliquots of the sample solution which have been treated with tartaric and boric acids and suitably buffered and is measured spectrophotometrically at 600 mμ. The selectivity of the method is improved by the use of EDTA as a masking agent. Forty-eight determinations of U in solutions containing known amounts of U and W to simulate alloys containing 20 to 65% of U gave an average recovery of 99.9% with a standard deviation of 0.36% for a single measurement. Most of the metals likely to be encountered as impurities can be tolerated in amounts up to 10% of the amount of uranium present. (auth)

15877 (MMPP-226-1) NEUTRON ABSORPTION IN PILE NEUTRON ACTIVATION ANALYSIS. Ove T. Hoegdahl (Michigan. Univ., Ann Arbor. Michigan Memorial-Phoenix Project). Dec. 1962. Contract AT(11-1)-1143. 72p.

An expression for the pile neutron-induced activity in a nuclide by an (n,γ) reaction under the assumption of no absorption effects is given first. The induced activity is expressed in terms of a thermal neutron density and a pile neutron absorption cross section or a resonance integral. The absorption effects of pile neutrons on the neutron induced activity are discussed, and the activity is expressed in terms of an average thermal neutron density and an effective pile neutron absorption cross section or an effective resonance integral. The absorption effect of the thermal neutrons is measured by the ratio of the average thermal neutron density inside the sample to the unperturbated thermal neutron density at the site of the sample prior to its insertion into the neutron flux. A comparison between theoretical and experimental values for this ratio for spherical samples is given. The effect of the absorption of the epithermal neutrons is shown to depend on the cadmium ratio and in a complex manner on the composition of the sample. A calculation of this effect on the pile neutron activation analysis of copper and gold in silver is given as an illustration of the calculations involved. The results are compared with experimental results. Methods by which the effects of neutron absorption can be eliminated or experimentally determined are reviewed, and their limitations are discussed. 42 references. (auth)

15878 (NDA-2154-5) EXPERIMENTAL DETERMINATION OF CONTAMINANTS IN SODIUM. Quarterly Progress Report for the Period, January 1, 1961 to March 31, 1961. H. Steinmetz (Nuclear Development Corp. of America, White Plains, N. Y.). May 1, 1961. Contract AT(30-1)-2303. 12p.

The experimental equipment used for the determination of oxygen in Na is described. Analytical results for a sample of Zr-gettered Na range from 0 to 32 ppm of oxygen. Efforts to improve the reproducibility of this analytical method are discussed. The apparatus for the determination of carbon in Na was set up and calibrated. (auth)

15879 (PG-Report-276) ANALYTICAL METHOD FOR THE DETERMINATION OF IRON IN URANIC LIQUORS AND COMPOUNDS AND IN URANIUM METAL. (United Kingdom Atomic Energy Authority. Production Group. Chemical Services Dept., Springfields, Lancs, England). 1963. 10p.

A method suitable for the determination of Fe up to 1500 ppm in uranic liquors and compounds calculated on a uranium basis with a limit of detection of 10 ppm is presented. A HNO_3 or HCl acid solution of the sample is obtained with $B(OH)_3$ being added if fluoride is present. The U is complexed with citrate and the Fe determined absorptiometrically as the thioglycollate after decomposition of the uranyl thioglycollate with ammonium carbonate. (H.G.G.)

15880 (PG-Report-393) ANALYTICAL METHOD FOR THE CONVERSION OF MISCELLANEOUS URANIC MATERIALS (OTHER THAN URANIUM METAL) TO URANIUM OXIDE FOR SPECTROGRAPHIC PURPOSES. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 5p.

Procedures for the preparative treatment required for a variety of uranic compounds prior to spectrographic examination for impurity elements are described. To provide complete analytical procedures, the method must be used in conjunction with the following analytical methods: the spectrographic analysis of uranium metal by the carrier distillation method; the spectrographic determination of aluminium in U_3O_8; and the spectrographic determination of calcium in uranium metal. The method covers the treatment of uranium dioxide in powder or pellet form, uranium tetrafluoride, uranyl fluoride, uranyl nitrate solution, ammonium diuranate, and the solution arising from the hydrolysis of uranium hexafluoride. (auth)

15881 (PG-Report-409) ANALYTICAL METHOD FOR THE ABSORPTIOMETRIC DETERMINATION OF BORON IN MAGNESIUM METAL. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 9p.

Magnesium is dissolved in H_2SO_4 in the presence of CH_3OH and B is separated by distillation as methyl borate. Rosocyanin is formed, separated from excess curcumin and dissolved in C_2H_5OH for absorptiometric measurement. (auth)

15882 (PG-Report-418) ANALYTICAL METHOD FOR THE GRAVIMETRIC DETERMINATION OF MOLYBDENUM IN URANIUM–MOLYBDENUM ALLOYS. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 4p.

The alloy is dissolved in nitric and hydrochloric acids. The solution is fumed with sulfuric acid, and the acidity is adjusted with hydrochloric acid to between 1 and 1.5N.

Molybdenum is precipitated as the N-Benzoylphenylhydroxylamine complex and weighed as such after drying at 105°C. (auth)

15883 (PG-Report-428) ANALYTICAL METHOD FOR THE DETERMINATION OF URANIUM IN 20 PERCENT TRIBUTYLPHOSPHATE/KEROSENE SOLUTION (X-RAY FLUORESCENCE). (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). 1963. 7p.

This method for the determination of U in 20% TBP/kerosene solution is based on standard fluorescence techniques for solution analysis. The sample is irradiated with the continuous spectrum from a W target x-ray tube and the intensity of the U Lα fluorescent radiation emitted is measured. The concentration of U is obtained from a calibration curve prepared with standards. In certain circumstances, Th is used as an internal standard. When an internal standard is used, the coefficient of variation was ±1% at 30 mg/ml for 10 results. (H.G.G.)

15884 (TID-16522) THERMAL NEUTRON ACTIVATION ANALYSIS OF TITANIUM USING 5.8-MINUTE TITANIUM-51 AND RAPID RADIOCHEMICAL SEPARATIONS. Chong Kuk Kim and W. Wayne Meinke (Michigan. Univ., Ann Arbor. Dept. of Chemistry). [1961]. Contract [AT(11-1)-1149]. 18p.

A nuclear reactor was used to determine trace amounts of Ti by neutron activation analysis in a variety of samples. A 10-minute radiochemical separation procedure coupled with γ spectrometry permitted measurement of the 5.8-minute Ti^{51}. With a neutron flux of $\sim 10^{12}$ n cm^{-2} sec^{-1}, the practical lower limit of detection was $\sim 6 \times 10^{-7}$ grams of Ti. (auth)

15885 (TID-18119) ANALYTICAL CHEMISTRY OF THE POLYPHOSPHATES. Final Report. William Rieman, III (Rutgers Univ., New Brunswick, N. J.). Feb. 28, 1963. Contract AT(30-1)-1306. 15p.

Research on methods for analysis of mixtures of condensed phosphates is reported. Areas of particular interest include isolation by ion-exchange chromatography and subsequent determination of the lower polyphosphates, and development of a method for determining the molecular weight distribution in compounds beyond the range of isolation. Ion-exchange chromatography is established as the most accurate and applicable analysis method. Work on determination of molecular-weight distribution is reported in a separate paper. (J.R.D.)

15886 (TID-18125) ACTIVATION ANALYSIS OF OCEAN BOTTOM CORES. Paul Kehler and Ralph Monaghan (Dresser Research. Div. of Dresser Industries, Inc., Tulsa, Okla.). Nov. 1962. Contract AT(40-1)-2969. 23p.

Equipment was constructed and a method developed for the analysis of ocean bottom cores for their content of Si, Al, Mg, Na, and Fe by neutron activation methods, and for their content of K, U, and Th by the spectrum of their natural radioactivity. Preliminary measurements were performed to determine the relative radiation of each element in a given energy bond. These constants, which are needed for the mathematical evaluation of the data, were found to depend strongly on the amount of water contained in the cores. The density of the cores must be considered for an accurate analysis. A core sampler for determining the density and water content of ocean bottom cores was used for these measurements. (H.G.G.)

15887 (TID-18304) DETERMINATION OF MICROGRAM AMOUNTS OF URANIUM BY NEUTRON ACTIVATION ANALYSIS USING THE 23.5-MINUTE U^{239}. M. Sankar Das (Michigan. Univ., Ann Arbor. Coll. of Literature, Science, and the Arts). Nov. 1962. Contract AT(11-1)-1143. 17p. (ORA-04997-1-P)

A neutron activation method was worked out for the determination of traces of U in a variety of samples. The nuclide chosen is the 23.5-minute U^{239}. Samples are irradiated for 20 minutes in a neutron flux of 10^{12}n cm^{-2} sec^{-1} using a pneumatic tube system delivering the samples into fume hoods in a matter of 3 seconds. Fast radiochemical separations in the presence of carrier uranium gives U^{239} in a radiochemically pure form. Activity measurements are taken on a β^- proportional counter or a γ scintillation detector with a multichannel analyser. The method has a higher practical sensitivity compared to those using Np^{239} or one of the fission products. As little as 5×10^{-9} gm of U present in a 1 gm sample can be determined by this method. The average total time required for a single analysis is less than 2 hours. The precision of the method was evaluated by analyzing standard samples. (auth)

15888 (TID-18257) AN INVESTIGATION OF COMPUTER COUPLED AUTOMATIC ACTIVATION ANALYSIS AND REMOTE LUNAR ANALYSIS. Quarterly Progress Report, November 1, 1962–February 1, 1963. Lloyd E. Fite, Edgar L. Steele, Richard E. Wainerdi, Edward Ibert, and Wayne Wilkins (Texas. Agricultural and Mechanical Coll., College Station. Engineering Experiment Station. Activation Analysis Research Lab.). Contract AT(40-1)-2671. 65p.

A description of the logic circuits governing the sequence of steps in the operations of the automatic activation analysis system is presented. The automatic system is able to resolve the γ spectrum of single and mixed radioisotopes with relatively long half lives, with a precision of 10%. A continuing effort through the use of the automatic activation analysis in the area of remote lunar analysis is described. A first generation remote activation analysis system is discussed and the results from the analysis of simulated lunar samples are given. These samples were processed in a geometrical configuration similar to what is expected on actual lunar exploration. (H.G.G.)

15889 (UNC-5050) DEVELOPMENT OF A CONTINUOUS METER FOR OXYGEN IN SODIUM. Quarterly Progress Report for the Period, September 1, 1962 to December 31, 1962. H. Steinmetz (United Nuclear Corp. Development Div., White Plains, N. Y.). Jan. 25, 1963. Contract AT(30-1)-2877. 22p.

Previous experiments have shown that it is possible to monitor the concentration of sodium oxide dissolved in liquid sodium by an electrochemical method. The electrochemical cell consists of a metal-metal oxide electrode, a calcia-stabilized zirconia electrolyte, and an electrode of sodium containing the dissolved sodium oxide whose concentration the cell determines. A pumped sodium loop for testing the electrochemical cells was designed and construction was started. Experiments with various electrochemical cells were continued. Cells with a $Cu-Cu_2O$ reference electrode proved to be the most stable and yielded the most reproducible results. Some anomalies were observed in the measurement of the temperature coefficient. Work was started on the development of more rugged electrochemical cells. (auth)

15890 (Y-1403) INSPECTION OF BERYLLIUM CHIPS BY NONFILM RADIATION IMAGING. R. E. Cofield (Union Carbide Nuclear Co. Y-12 Plant, Oak Ridge, Tenn.). Nov. 16, 1962. Contract W-7405-eng-26. 21p.

Consideration of nonfilm radiation imaging methods for

the detection of foreign inclusions in Be chips indicated that x-ray fluoroscopy is a suitable technique. Fluoroscopy can easily detect $\frac{1}{16}$ by $\frac{1}{16}$ by 0.004-inch-thick Al in $\frac{3}{4}$-inch-thick layers of Be chips and is superior to imaging on an x-ray-sensitive television camera tube. A fluoroscopic inspection cabinet was designed and utilized for the batch inspection of Be chips in machine shop and chip salvage areas, and a system was conceived for the continuous inspection of large quantities of chips, utilizing fluoroscopic image amplification. This system is possibly suitable for complete automation by utilizing electronic recognition of debris and automatic separation of rejected chips from acceptable material. (auth)

15891 (CEA-tr-A-1245) DÉTERMINATION DU RAPPORT C/H DE CARBURES D'HYDROGENE À L'AIDE DE NEUTRONS. (Determination of the C/H Ratio of Hydrocarbons by Means of Neutrons). R. Tornau and K. H. Waechter. Translated into French from Chem.-Ingr.-Tech., 34: No. 1, 35-8(1962). 18p.

The hydrogen concentration of liquid or solid materials at rest or in movement can be determined by measurement of the absorption or reflection of neutrons. As the measurement gives the mean for a relatively large volume, marginal perturbations or heterogeneities of the product measured are without effect on the measurement results. The measurement apparatus is sturdy, insensitive to perturbations, and sure in operation. The method is suitable for a continuous measurement and the results can be recorded or used for control. (tr-auth)

15892 CONTRIBUTIONS TO THE ANALYSIS OF NUCLEAR FISSION PRODUCTS. H. E. Roellig, E. Trommer, and A. Minenko (Zentralinstitut für Kernphysik, Rossendorf, Ger.). Acta Chim. Acad. Sci. Hung., 32: 159-69(1962). (In German)

Analytical techniques are described for determination of contaminants (C, O, Fe, Cu, Al, Ni, Zn, Pb, Zr, Si) in processed fission products, such as U and U oxides. O is determined by heating U products to 2200°C and extraction of O by a vacuum. CO_2 in the extracted gas is absorbed by alkali and O is converted to H_2O, with H_2 and a Pt catalyst, and measured. CO_2 is determined by absorption in $Ba(OH)_2$ and the $BaCO_2$ formed is estimated by an electrolytic potentiometric technique. The metal contaminants of U products were determined by photometric and colorimetric procedures. Pb, Zn, and Cu were extracted from U with HNO_3 and estimated colorimetrically with Dithizon as indicator. By this method, 20 μg Pb could be determined with an accuracy of ±3% in 1 g U. Cr was extracted from U with H_2SO_4 and estimated with diphenylcarbizide. Al was measured with the aid of Aluminon, and thioglycolic acid to prevent interference of Fe. Fe and Ni were extracted from U products with H_2SO_4–HF, Fe being determined spectrophotometrically with the aid of α,α′-dipyridyl and Ni with dimethylglyoxime. Zr in U–Zr alloys was quantitatively determined by the use of Cupferron as a precipitant and Si in U–Si alloys by NaOH–Na_2O_2. (H.H.D.)

15893 A SIMPLE MULTIELEMENT-CALIBRATION SYSTEM FOR ANALYSIS OF MINOR AND MAJOR ELEMENTS IN MINERALS BY FLUORESCENT X-RAY SPECTROGRAPHY. Merlyn L. Salmon (FLUO-X-SPEC Lab., Denver). Advan. X-Ray Anal., 5: 389-404(1962).

Techniques of mineral analysis by fluorescent x-ray spectrography can generally be classified on the basis of (1) extensive sample preparation and simple instrumental examination, (2) simple sample preparation and extensive instrumental examination, (3) extensive processes for both, or (4) simple processes for both major phases of the technique. The latter type of technique is usually the most commensurate with the concept "maximum information with minimum effort." Suitable analytical results with multielement calibration systems for random mineral samples can be obtained if there are valid considerations of the relevant absorption and enhancement effects or if the systems are based on general procedures to minimize absorption and enhancement effects. Preliminary investigation indicated that control of sample mass and use of thin films of the mineral sample is a convenient and simple method of minimizing absorption and enhancement effects. Successful application of thin-film samples with known masses in a multielement calibration system is highly dependent upon details of sample preparation and comprehensive studies of these details will be discussed. The calibration system is suitable for the determination of minor and major concentrations in the sample, but it is not recommended for determination of trace concentrations. (auth)

15894 A SIMPLE DIRECT METHOD FOR DETERMINING RADIOACTIVITY IN FECES. John D. Bonnet, Nicholas C. Hightower, Jr., Zoltan Petrany, and Arno W. Sommer (Scott and White Clinic, Temple, Tex.). Am. J. Digest. Diseases, 6: 520-5(June 1961).

A method is described for determining the radioactivity of any isotope employed clinically, which emits gamma rays (radioiodine as radioiodinated triolein or radioiodinated oleic acid, radiochromium, and radioiron). A standard, plastic-lined carton was used to the collection of individual stool specimens. The containers have a uniform internal diameter of 85 mm, which approaches that of the sodium iodide crystal (dia 63 mm) in the well counter. A tamper was used to indicate the height of feces in the carton; it could be read directly from the tamper handle. When stool specimens are collected individually in separate cartons, the radioactivity is homogeneously distributed throughout the specimen. The observed variation of the administered dose of radioisotope determined in the specimen was not greater than 1%. Use of a commercially available garbage disposal unit, that pulverizes the carton and specimen and flushes it into the sewer, allows processing of specimens without direct handling and enables rapid analysis of a large number of specimens. (P.C.H.)

15895 QUANTITATIVE AUTORADIOGRAPHIC DETERMINATION OF URANIUM. Antionia Catino. Ann. Chim. (Rome), 52: 184-6(Feb.-Mar. 1962). (In Italian)

A method is given for the quantitative autoradiographic determination of U. Lead containers are filled with U salts or mineral and placed on a film for 24 hr. The film is developed and the black points are spectrophotometrically compared with points on standard films to determine the U content. (P.C.H.)

15896 SPECTROCHEMICAL DETERMINATION OF IMPURITIES IN NEPTUNIUM. J. A. Wheat (E. I. du Pont de Nemours and Co., Aiken, S. C.). Appl. Spectry., 16: 108-9(1962).

The ion-exchange method of Ko for the analysis of plutonium was adapted for the determination of impurities in neptunium. When Ko's method for the analysis of plutonium was applied directly without modification, only 70% of the neptunium was retained by the resin because the strong nitric acid readily oxidized Np(IV) to the V and VI valence states. Neptunium was reduced to and held in the tetravalent state by hydrazine and sulfamic acid, but attempts to increase neptunium retention above 98% were unsuccessful with reducing agents that did not contain metal cations. However, two successive treatments of the

neptunium solution with resin removed 99.96% of the neptunium from solution. The effluent containing the impurities was dried and analyzed spectrographically. This method can be used for the spectrochemical determination of Fe, Cr, Ni, Mn, Cu, Al, and Mg in Np or any of its compounds that can be dissolved in nitric acid. (M.C.G)

15897 THE DETERMINATION OF IRON IN TERPHENYL BY X-RAY EMISSION SPECTROSCOPY. L. W. Wray (Atomic Energy of Canada Ltd., Chalk River, Ont.). Appl. Spectry., 16: 140-1(1962).

A method using x-ray emission spectroscopy was developed for determination of iron in terphenyl with a limit of detection of 2 μg Fe/g of terphenyl. Standards were prepared by dissolving the cupferron complex of iron in terphenyl. (M.C.G.)

15898 ION EXCHANGE-SPECTROGRAPHIC DETERMINATION OF THORIUM IN URANIUM ORES. R. Ko (General Electric Co., Richland, Wash.). Appl. Spectry., 16: 157-9(1962).

The determination of 0.01 ppm of thorium in 1 g of uranium ore by a combined ion exchange-spectrographic analysis is presented. Thorium is separated from the chemically complex ore solution by anion exchange in hydrochloric and nitric acid media and determined spectrographically using zirconium as the internal standard. The precision of the method expressed as a coefficient of variation is estimated to be ±6%. (auth)

15899 BUFFER EFFECTS IN THE SPECTROCHEMICAL ANALYSIS OF NIOBIUM–TANTALUM MIXTURES. Makoto Nakano (Government Industrial Research Inst., Nagoya, Japan). Appl. Spectry., 16: 165-7(1962).

The effects of various buffers on the precision and sensitivity of d-c arc procedures for the determination of low concentrations of niobium in tantalum and of tantalum in niobium. The buffers studied include: graphite, Li_2CO_3, Cu, SiO_2, ZnO, Al, Ga_2O_3, and La_2O_3. It was concluded that graphite is the optimum buffer for use in the determination of low concentrations of tantalum in niobium, whereas lanthanum oxide is the best buffer to use for the determination of niobium in tantalum. (M.C.G.)

15900 X-RAY SPECTRUM ANALYSIS OF Ta, Cb AND SEVERAL ALLOYING ELEMENTS IN Ta and Cb CONTAINING SUBSTANCES. Hans Rothmann, Helga Schneider, Johannes Niebuhr, and Curt Pothmann. Arch. Eisenhuettenw., 33: 17-22(Jan. 1962).

The x-ray spectrum analysis of Ta and Nb in ores, slags, and alloys after isolation of acids is presented. Ta, Nb, and alloying elements were determined in acid-soluble alloys with chemical separation and the simultaneous analysis of Ta, Nb, Fe, Mn, and Sn was made in ores after fluxing with boric acid. (P.C.H.)

15901 THE ESTIMATION OF THE CEMENT CONTENT OF FINISHED CONCRETE BY DETERMINING THE TOTAL HYDROGEN AMOUNT AS WATER USING FAST NEUTRON SCATTERING. E. Yaltkaya and S. Senturk. RILEM; Bull. Intern. Union Testing Res. Lab. Mater. Struct., (N.S.), No. 15, 110-13(June 1962).

The well-known method of measuring soil humidity by neutron scattering was modified for determining chemically the bound hydration water of cement in finished concrete as an indication of its cement content. The method depends on the property of slowing down fast neutrons to thermal neutrons by collision with the H atoms of water. Since the water bound by cement is in a constant relationship to it, irrespective of its origin and type, the cement content of concrete can be estimated from its water content, provided that the absorbed moisture has been expelled. Po^{210}–Be sealed in an Al capsule is used as the neutron source, and a BF_3-filled counter is used as the detector. The procedure is described, and the cement content of the sample in kg/cc can be calculated according to the formula, $D = (W/4\rho - 1)(5000d/x)$, where W is the water content, ρ is the density, and x is the weight percentage of the water chemically bound. (OID)

15902 THE MEASUREMENT OF WATER CONTENT OF THIN SAMPLES BY MEANS OF THE DIFFUSION OF THERMAL NEUTRONS. R. Lachaud. RILEM; Bull. Intern. Union Testing Res. Lab. Mater. Struct., (N. S.), No. 15, 145-50(June 1962).

A method for the measurement of water content in thin samples is based on the fact that the diffusion cross section of thermal neutrons for H is very large in comparison with the total diffusion cross-section, which is in the vicinity of 0.11 cm^2/g, for common materials. The emission of thermal neutrons is produced by a neutron gun in which a source of Ra^{226}–Be is surrounded by paraffin in order to obtain complete thermalization of neutrons. About 40 mC of Ra^{226}–Be are placed in the center of a paraffin block, which is encased in a double layer of Cd and B_4C. A 15-mm dia channel is drilled into the paraffin block as an outlet for the neutron flux. A 20-mm thick sample, in which the water content is to be determined, is placed in front of the outlet. B_4C shields, in which small windows are drilled to serve as collimators, are placed in front of and behind the sample. The neutron flux is measured with BF_3 gas-filled counters placed in front of the collimators. If the window is 10 cm^2, the intensity without the sample is about 3000 pulse/min, while the background is only 230 pulses. The results are expressed as a function of flux attenuation or as a ratio of I/I. In this way, the absorption due to pure water and to the water content of cement, sand, limonite, baryta, and other materials can be determined. (OID)

15903 HUMIDITY MEASUREMENTS OF BUILDING SITES BY MEANS OF NEUTRON INDUCED RADIOACTIVITY. A. Gibert. RILEM; Bull. Intern. Union Testing Res. Lab. Mater. Struct., (N.S.), No. 15, 152-4(June 1962).

The use of BF_3 counting tubes measuring humidity by the activation of certain nuclides, has the advantages of reproducibility and simple equipment. Thin Rh foils are used as activation indicators, and 10 mC Ra^{226} + Be is used as the neutron source. The assembly of source and Rh foil is placed either in a water-filled container or in a paraffin block surrounded by a layer of borax. The degree of activation of Rh is inversely proportional to the humidity. (P.C.H.)

15904 THE DIRECT DETERMINATION OF I^{131} IN HETEROGENEOUS FECAL SPECIMENS. Arthur F. Dratz and James C. Coberly (Veterans Administration Hospital, Atlanta). Gastroenterology, 41: 380-4(Oct. 1961).

An improved method for the direct determination of I^{131} in fecal samples was developed which, by means of specialized counting geometry, overcomes some of the difficulties associated with the measurement of nonhomogeneous samples at short sample-to-detector distances. It has a sensitivity of 7500 cpm per μC and utilizes materials normally available in modestly equipped radioisotope laboratories. For samples of 1 to 350 ml the maximal observed error due to uneven distribution of activity was less than ±7 parts per hundred. If a suitable template is provided for reproducibility of geometry, the scintillation probe can conveniently be employed for other laboratory procedures, such as thyroid uptake studies. It can also be adapted to counting problems such as the radioassay of intact mouse

or rat carcasses, or of large samples of excised tissue. (P.C.H.)

15905 SPECTROMETRIC DETERMINATION OF Pb^{204}. A. G. Zhiglinskii, A. N. Zaidel, and G. G. Kund (Leningrad State Univ.). Geokhimiya, No. 1, 88-91(Jan. 1963). (In Russian)

An improved autocollimation interferometer capable of producing highly contrasting interferograms enabled an efficient quantitative determination of less than 1.5% Pb^{204}. (R.V.J.)

15906 DETERMINATION OF SMALL AMOUNTS OF LONG CHAIN ALIPHATIC AMINES IN AQUEOUS SOLUTION. PART II. SOME OBSERVATIONS ON THE COBALT THIOCYANATE METHOD. M. W. Desai and T. K. S. Murthy (Atomic Energy Establishment, Trombay, India). Indian J. Chem., 1: 106-8(1963).

A modified method for the determination of some tertiary alkyl amines used as extractants of uranium from sulfate solutions is described. The method based on the extraction of the blue amine-cobalt thiocyanate complex by organic solvents, was studied in detail. For overcoming interference due to some of the constituents of the natural leach liquors in which the content of dissolved or entrained amine has to be determined, it was necessary to extract the amine first into carbon tetrachloride and then develop the color in the organic layer by contacting it with aqueous cobalt thiocyanate solution. Analyses of the organic extracts indicated that the complex involved is of the type $[Co(CNS)_6]^{4-}$. (auth)

15907 AMPEROMETRIC DETERMINATION OF TRIVALENT CERIUM AS MOLYBDATE. R. S. Saxena and M. L. Mittal (Government Coll., Kota, India). Indian J. Chem., 1: 139-40(1963).

A simple and rapid method for the determination of Ce(III) by amperometric titration with sodium molybdate was developed. Small amounts of Ce can be determined by the method with an accuracy of 1% in the pH range 5.8 to 6.2 using a manual polarograph with a scalamp galvanometer for measuring the current. (auth)

15908 X-RAY SPECTROMETRIC DETERMINATION OF LIGHT ELEMENTS USING DIRECT ELECTRON EXCITATION. J. G. M. Fox. J. Inst. Metals, 91: 239-41(Mar. 1963).

The use of a low-energy electron beam as exciting source should improve the sensitivity of x-ray fluorescence determination of the light elements. Calibration graphs were obtained for Mg, Al, Si, and P in a number of matrixes using 4-kv excitation potential, and it was found that the usually large matrix absorption effect encountered with x-ray excitation was replaced by a slight enhancement effect. A table of intensities is presented for 1% concentrations of the above elements. (D.L.C.)

15909 SEPARATION AND DETERMINATION OF THORIUM AND SCANDIUM. Shu-ch'uan Liang and Shui-chieh Hung. K'o Hsueh T'ung Pao, No. 9, 42-3(1961).

Three methods are proposed for the separation and determination of Th and Sc, using m-nitrobenzoic acid (I), quinoline-2-carboxylic acid (II), and tetrachlorophthalic acid (III). On using (I), Th is precipitated at pH 1.5 to 1.8 (double re-precipitation), and Sc at pH 2.8 to 3.0. Considerable amounts of NO_3^- and Cl^- do not interfere with the precipitation, but SO_4^{2-} and CH_3COO^- interfere with precipitation of Sc because of formation of complex ions. By this method a satisfactory separation of a Th–Sc mixture is effected at $ThO_2:Sc_2O_3$ ratios from 1.7:1 to 19.6:1, with an absolute error from –0.2 to +0.5 mg ThO_2 and –0.2 to +0.3 mg Sc_2O_3. The minimum determinable amount of Sc_2O_3 is 1 mg. On using (II), Th is precipitated at pH 3.4 to 3.5 (double re-precipitation), and Sc at pH 7. By this method Th and Sc are separated at $ThO_2:Sc_2O_3$ ratios from 1.66:1 to 6.6:1, with an absolute error of –0.6 to +0.7 mg ThO_2 and –0.5 to +0.4 mg Sc_2O_3. With (III), Th is precipitated at pH 1 to 1.2 and Sc at pH 2.5 to 4.4, in the form of $[C_6Cl_4(COO)_2]_3Sc_2$. By this method 1 to 102 mg Sc_2O_3 can be determined. (P.C.H.)

15910 SPECTROPHOTOMETRIC DETERMINATION OF THORIUM WITH THE USE OF XYLENOL ORANGE. Lan-hsiang Li. K'o Hsueh T'ung Pao, No. 9, 43-4(1961).

A study was made of the conditions of spectrophotometric determination of micro amounts of Th with Xylenol Orange (I). It was found that maximum of optical density of the Th–(I) complex is at 560 mμ and does not depend on acidity of the solution within the range of pH 2.5 to 3.5. Intensity of coloration reaches maximal development after 1 min following the mixing of the solutions and remains unchanged for ≥48 hr, and for a week in the dark. The interfering anions are F^-, S^{2-}, $C_2O_4^{2-}$, and MnO_4^{2-}. The interfering effect of large amounts of Fe^{3+} and Ce^{4+} is eliminated by reducing them with $NH_2OH \cdot HCl$. To plot a calibration graph, into each of 9 measuring flasks of 100-ml capacity are placed 1 ml 0.03% solution (I), 50 ml water, a drop of 0.2N HNO_3 (the solution turns yellow), 5 ml of a pH 3 buffer solution ($ClCH_2COOH$ + NaOH) and 0.0 to 0.16 mg Th; diluted with water and spectrophotometered at 560 mμ. Beer's law holds with concentration of Th of 0.02 to 0.14 mg per 100 ml solution. Relative error ≈3%. (P.C.H.)

15911 AN ACTIVE CONTAMINANT IN THE RADIOISOTOPE YTTRIUM 90. D. Vodros (Medical Univ., Budapest). Magy. Radiol., 14: 358-60(Dec. 1962).

In Y^{90} preparations used in human therapy, which should emit only β radiation, a γ radiating contaminant was observed. On the basis of the determination of the half-time of decay and the γ spectrum, the contaminant proved to be Ir^{192}. (OTS)

15912 THE DETERMINATION OF SILVER IN MATERIALS WITH HIGH CADMIUM CONTENT BY ACTIVATION ANALYSIS. I. THE ELECTROLYTIC SEPARATION OF SILVER FROM CADMIUM. Franz Lux (Technische Hochschule, Munich). Radiochim. Acta, 1: No. 1, 20-7(Sept. 1962). (In German)

The determination, by activation analysis, of traces of silver in CdS and in (Cd + Zn)S is complicated by certain nuclear reactions, e.g., $Cd^{110}(n,p)Ag^{110}$. This difficulty can be overcome by an electrolytic separation of the silver before neutron irradiation. A radioactive tracer was used to determine the conditions for obtaining a quantitative separation of 1 microgram of silver or less from 1 gram of cadmium. (auth)

15913 PROCESS ANALYSIS BY POST-ACTIVATION METHOD. Toru Hirayama, Mitsuteru Nitto, Takaya Hiraoka, and Kazuyoshi Hamada. Radioisotopes (Tokyo), 11: 265-74(Aug. 1962). (In Japanese)

A method is described whereby an Al-Au alloy is introduced into a process line, and samples are removed from various points along the line, as though the Al-Au were a radioactive tracer. The samples are then subjected to neutron activation analysis, and examination of the changes in Au content are used to analyze the process parameters. (T.F.H.)

15914 NUCLEAR ACTIVATION ANALYSIS. RECENT DEVELOPMENTS IN THE TECHNIQUE AND ITS INHERENT ATTRIBUTES GIVE PROMISE OF WIDE APPLICABILITY. Richard E. Wainerdi and Normand P. DuBeau (Texas Agricultural and Mechanical Coll., College Station). Science, 139: 1027-33(Mar. 15, 1963).

A review is presented of recent developments in activation analysis. The method, choice of procedures and equipment, and applications are discussed. (D.L.C.)

15915 STUDY ON RAPID ANALYSIS BY RADIOACTIVATION. I. SIMPLE METHOD OF GRAPHICAL ESTIMATION FOR RADIOACTIVITY INDUCED BY NEUTRON IRRADIATION. Minoru Okada. Tokyo Kogyo Shikensho Hokoku, 58: 1-6(Jan. 1963). (In Japanese)

The simple method of estimation for radioactivity induced by neutron irradiation was found in which the estimation was made by moving a curve of certain shape on a graph that showed, using a log–log paper, thermal neutron activation cross section per unit mass of naturally occurring element against half life of product nuclide. Further simplification was made by substituting a couple of straight lines for the curve. (auth)

15916 STUDY ON RAPID ANALYSIS BY RADIOACTIVATION. II. SIMULTANEOUS DETERMINATION OF VANADIUM AND ALUMINUM IN GRAPHITE. Minoru Okada. Tokyo Kogyo Shikensho Hokoku, 58: 7-10(Jan. 1963). (In Japanese)

The method of determination of vanadium and aluminum in graphite was studied. In the method, sample is placed for 3 minutes in the nuclear reactor JRR-1 to be irradiated by neutrons at a flux of 3×10^{11} neutrons per sq. cm per second, and then counted for 2 minutes by 2 in. thick sodium iodide crystal connected with a 256-channel pulse height analyzer. The photopeak height due to vanadium-52 and that due to aluminum-28 are measured respectively. Vanadium and aluminum are thus determined simultaneously, when comparative standards are used. Both of the elements could be determined down to a 10^{-1} ppm. The estimated coefficient of variation of single determinations is about 10% for 0.1 ppm vanadium, and about 20% for 0.2 ppm aluminum. (auth)

15917 STUDY ON RAPID ANALYSIS BY RADIOACTIVATION. III. DETERMINATION OF SELENIUM BY SELENIUM-77^{m} (17 SEC). Minoru Okada. Tokyo Kogyo Shikensho Hokoku, 58: 11-15(Jan. 1963). (In Japanese)

The method of determination of selenium in sulfur and sulfur compounds was studied. In the method, sample ($2 \sim 0.1$ gram) is placed for 20 seconds in the nuclear reactor JRR-1 to be irradiated by neutrons at a flux of 3×10^{11} neutrons per sq. cm per second. Induced activity is measured by a 256 channel gamma scintillation spectrometer. Counting operation consists of two parts. At the first counting operation, one half of the channels are used, and at the second time the rest of the channels are used. Each counting time is 20 seconds. From the photopeaks in the gamma spectrogram, selenium is determined. The selenium contents ranging from 10^{2} to 10^{-2} ppm were determined. The coefficient of variation of single analyses is estimated at about 10% for a few micrograms of selenium. (auth)

15918 COMPLEX COMPOUNDS OF METALS WITH HYDROXY ACIDS. I. V. Pyatnitskii (Kiev State Univ.). Usp. Khim., 32: 93-119(Jan. 1963). (In Russian)

The chemical technology of metal complexes with hydroxy acids was reviewed. The synthesis of complex compounds, physico-chemical methods of analysis, composition and stability of tartrate and citrate complexes, and the relation between the stability of complexes and the structure of the oxy acid addends are discussed, as well as the applications of tartaric and other acids in metal analysis and determination. 278 references are included. (R.V.J.)

15919 ACTIVATION ANALYSIS OF THE IMPURITIES IN METAL. Ryuthei Kurosawa. Waseda Daigaku Rikogaku Kenkyusho Hokoku, No. 18, 15-25(Dec. 1961). (In Japanese)

Micro impurities were determined in Bi samples by activation analysis and gamma spectrometry using a multichannel pulse height analyzer. The samples were irradiated under 3×10^{11} n/cm^2 for 15 to 45 hr and treated by chemical separation. (P.C.H.)

15920 DETERMINATION OF Sc IN COAL ASH FOLLOWING PAPER CHROMATOGRAPHIC SEPARATION. B. Ya. Kaplan and I. V. Ol'shevskaya (Central Chemical Lab. of the Geological Survey, USSR). Zavodsk. Lab., 29: 26-7(1963). (In Russian)

Separation of Sc was achieved by preliminary precipitation of Sc and Y tartrates on caustic soda followed by paper chromatography and colorimetric determination using alizarin. The method is capable of determining 0.005% Sc_2O_3 in ash. (R.V.J.)

15921 COMPLEXOMETRIC DETERMINATION OF Zr AND Th BY XYLENOL ORANGE. R. S. Volodarskaya and G. N. Derevyanko. Zavodsk. Lab., 29: 28-9(1963). (In Russian)

A complexometric method of Zr determination in magnesium, aluminium, and copper alloys (where the presence of Fe(III) and Ce(IV) is eliminated by hydrochloric hydroxylamine) is described. Consequent determination of Th and Zr in Mg alloys (with 0.1 to 5% Zr and Th) is also described. (tr-auth)

15922 AMPEROMETRIC DETERMINATION OF U USING GRAPHITE ELECTRODE. Z. B. Rozhdestvenskaya, O. A. Songina, and V. G. Barikov (Kazakh State Univ., USSR). Zavodsk. Lab., 29: 30-3(1963). (In Russian)

Determination of submicrogram amounts of U by amperometric titration with trilon B in the presence of mercury salts and using a graphite electrode is described. (tr-auth)

15923 CHEMICO-SPECTROGRAPHIC METHOD FOR THE DETERMINATION OF ADMIXTURES IN ALKALINE METALS. A. V. Vinogradov, M. I. Dronova, and Yu. I. Korovin. Zhur. Analit. Khim., 18: 29-32(Jan. 1963). (In Russian)

A chemico-spectrographic method was developed for the determination of admixtures in alkaline metals. The concentration of admixtures is carried out by extracting 8-hydroxyquinolinates and cupferronates with a mixture of butyl alcohol with chloroform from an aqueous solution of the sample at controlled pH values. The spectrographic analysis of the concentrate is carried out by the method of three standards using a spark excitation of the spectra of a powder sample and an inner standard. The sensitivity of the method at the concentration coefficient equal to 100 is from 1×10^{-4} to 3×10^{-4} % for different elements. The accuracy of the method is 10 to 20%. (auth)

15924 USE OF CINNAMIC ACID IN ANALYTICAL CHEMISTRY. III. SEPARATION OF INDIUM AND GALLIUM FROM MANGANESE, NICKEL, COBALT, AND ZINC. E. A. Ostroumov and I. I. Volkov (Inst. of Oceanology, Moscow). Zhur. Analit. Khim., 18: 52-7(Jan. 1963). (In Russian)

A new method for the quantitative precipitation of In and Ga by means of cinnamic acid was developed to permit their separation from Mn, Ni, Co, and Zn. Ammonium cinnamate quantitatively precipitates In and Ga from a weak acid solution on heating, whereas Mn, Ni, Co, and Zn remain in the solution. The composition of compounds formed by cinnamic acid with In and Ga under the precipitation conditions was determined. The formation of a soluble ammonium derivative of the base gallium cinnamate was established and optimum conditions were found for its hydrolytic decomposition with the quantitative separation of the base salt. The base indium and gallium cinnamates, which pre-

cipitate in a solid form, are easily filtered and washed. The sorption of bivalent metals, Mn, Ni, Co, and Zn, (remaining in the solution) with the base salt precipitate is not more than some hundredth parts of a milligram; so the separation is achieved by a single precipitation. Nitrates and sulfates do not interfere. (auth)

15925 DETERMINATION OF NEODYMIUM BY A METHOD OF RADIOMETRIC TITRATION WITH 8-HYDROXYQUINOLINE HALOGEN DERIVATIVES. B. M. Maryanov and V. V. Serebrennikov (Kuibyshev Tomsk State Univ.). Zhur. Analit. Khim., 18: 58-60(Jan. 1963). (In Russian)

A new method was developed for the determination of gamma quantities of neodymium by radiometric titration of neodymium salts with alkaline solutions of 5,7-dichloro- and 5,7-dibromo-8-hydroxyquinoline. A comparison was made of the radiometric titration of certain rare earths with oxalic acid, cupferron, 8-hydroxyquinoline, and its halogen derivatives. The accuracy of the method is 3 to 7.5%. (auth)

15926 ANALYTICAL APPLICATION OF DIBROMARSENAZO II. DETERMINATION OF THORIUM IN THE PRESENCE OF RARE EARTHS. S. B. Savvin, N. N. Basargin, and V. P. Makarova (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Zhur. Analit. Khim., 18: 61-5(Jan. 1963). (In Russian)

Dibromarsenazo II was used for the determination of thorium in the presence of rare earths, which do not interfere in 1N HCl up to a ratio of 1:5000. The sensitivity of the determination is 0.05 μg/ml Th; sulfates and phosphates do not interfere with thorium determination up to 100 mg in 25 ml. (auth)

15927 A COMPARATIVE STUDY OF THE ABSORPTION SPECTRA OF ZIRCONIUM COMPLEXES AND IONIC FORMS OF REAGENTS. A. K. Babko and V. T. Vasilenko (Inst. of General and Inorganic Chemistry, Kiev). Zhur. Analit. Khim., 18: 71-8(Jan. 1963). (In Russian)

A comparison was made of the absorption spectra of 14 reagents for zirconium in order to facilitate the preliminary estimation and choice of a reagent for photometric determination. For a number of reagents complexing is caused by the same acid groups as the pH-indicator properties; it was found that $\lambda_{HR} \leq \lambda_{ZrR} \leq \lambda_{R-}$. The shift of the reagent absorption maximum on complexing with zirconium increases with the increase of the maximum shift on the formation of its anionic form R-. The intensity of absorption in most cases has the same succession. It is shown that for the reagents with the reacting groups of the same type on the conversion to the anionic form and on the complexing with zirconium the shift of λ_{max} is greater for more weak acids; $\Delta\lambda$ increases with the increase of pH of the first change of the reagent color. The azo group of some azo dyes participates in the formation of the coordination bond with metal; in these cases $\lambda_{HR} < \lambda_{ZrR} > \lambda_{R-}$. The difference between λ_{ZrR} and λ_{HR} for the reagents is usually less; the difference in the absorption intensity is rather large. (auth)

15928 ON THE LUMINESCENT DETERMINATION OF URANIUM, CERIUM, AND NIOBIUM. A. M. Ushakova (Inst. of Geological Sciences, Kiev). Zhur. Analit. Khim., 18: 79-81(Jan. 1963). (In Russian)

Experimental data on the effect of certain elements impurities (Ca, Mg, Mn, Th, Zn, Nd, Nb, and Ce) on the luminescence of U are given, as well as the data on the luminescent determination of Ce and Nb. It was established that Ca, Mg, and Mn decrease the luminescence of U beads to a considerable degree, especially Mn and Ca at concentrations from 0.05 to 0.1%. The extinction gradients are correspondingly for Mn and Ca (U 1.2g/Mn 0.01%) and (U 2.0g/Ca 0.01%) and for Mg and Ca (at concentrations from 0.01 to 0.05%) (U 0.55g/Mg 0.01%) and (U 0.72g/Ca 0.01%). It was also established that Ce compounds have a red luminescence in ultraviolet light. The luminescence intensity depends on the Ce concentration and there is no luminescence when Ce concentration is equal or less than 0.001%. A relation was found between the luminescence intensity of Nb beads and their Nb concentration, which proves the possibility of Nb determination by a luminescent method. Niobium can be determined by this method at concentrations not less than 5×10^{-4}%. (auth)

15929 EXTRACTION-PHOTOMETRIC DETERMINATION OF NIOBIUM BY MEANS OF LUMOGALLION. I. P. Alimarin and Hsi-I Han (Moscow State Univ.). Zhur. Analit. Khim., 18: 82-7(Jan. 1963). (In Russian)

The interaction of Nb with lumogallion was studied, and the spectrophotometric characteristics of the complex formed were investigated. It was established by the method of isomolar series that Nb interacts with lumogallion at a ratio of Nb : R = 1 : 1. The mean value of the reaction equilibrium constant was found to be equal to 5.6. The lumogallion acid dissociation constants are $pK_1 = 5.6$ and $pK_2 = 7.15$. Citric and oxalic acids interfere with the determination of Nb. Tartaric acid does not interfere. Extraction of the reagent and its complexes with Nb, Ta, and Zr with n-butyl alcohol was studied, and a method for the determination of Nb in the presence of the above elements was developed. (auth)

15930 THE EFFECT OF PHOSPHOMOLYBDATE ON THE SPECTROGRAPHIC DETERMINATION OF NIOBIUM AND TANTALUM. K. A. Semenenko and N. I. Tarasevich (Moscow State Univ.). Zhur. Analit. Khim., 18: 88-92(Jan. 1963). (In Russian)

The behavior of microamounts of Nb and Ta on the background of macroamounts of Mo during the spectrographic determination of Nb and Ta on the basis of $P_2O_5 \cdot xMoO_3$ is described. The sensitivity of the direct spectrographic analysis is 10^{-2}% of Nb and Ta and depends on the way of introduction of all the components of the compound $P_2O_5 \cdot xMoO_3 + Nb_2O_5 + Ta_2O_5$ from the carbon electrode crater into the arc space, and on the specific conditions of excitation of Nb and Ta in a certain case. (auth)

15931 INTERACTION OF URANIUM(VI) WITH ARSENAZO III STRONGLY ACID SOLUTIONS. A. A. Nemodruk and L. P. Glukhova. Zhur. Analit. Khim., 18: 93-8(Jan. 1963). (In Russian)

A simple photometric method was worked out for determining U in solutions containing large amounts of Al, Fe(III), Mg, Zn, Ca, Cr(III), Mn(II), Ni, Co, and many other elements without U separation. The method is based on the measurement of the optical density of solutions of the U(VI)–arsenazo III complex in 6M nitric acid. The mean experimental error is not more than 2.1%. The time required for a determination is about 5 min. The maximum absorption is at 656 mμ, the molar extinction coefficient is about 60,000. Uranium and arsenazo III interact in a molar ratio of 1:1. (auth)

15932 SPECTROGRAPHIC DETERMINATION OF ADMIXTURES IN LANTHANUM OXIDE OF HIGH PURITY AFTER THEIR CONCENTRATION BY A CHROMATOGRAPHIC METHOD. V. L. Kustas, G. V. Lazebnaya, and M. K. Zagorskaya. Zhur. Analit. Khim., 18: 99-102(Jan. 1963). (In Russian)

When Ce, Pr, Nd, and Sm admixtures in lanthanum oxide of high purity are determined spectrographically, they are

concentrated by an ion exchange chromatographic method. Owing to this, the relative sensitivity of their determination is increased by 1 to 2 orders. The relative experimental error is ±4–6%. (auth)

15933 COMBUSTION IN A BOMB OF METAL. Charles E. Holley, Jr., and Elmer J. Huber, Jr. p.77-94 of "Experimental Thermochemistry. Vol. 2." New York, John Wiley and Sons, 1962.

Methods for determining metal impurity contents are presented, and ignition techniques using fuse wire, auxiliary combustible materials, or aids such as paraffin oil, are discussed. Ignition, ignition aid, O_2 pressure, and container composition methods used in determining oxide composition and combustion heat from burning Al, As, Be, Cr, Cd, Nb, Lu, Se, Si, U, and other materials are tabulated. (P.C.H.)

15934 APPLICATION OF THE COPPER SPARK METHOD FOR SPECTROGRAPHIC ANALYSIS. J. P. Faris (Argonne National Lab., Ill.). Dec. 1962. 27p. (TID-18159; UAC-7108)

To be published in TID-7655, Proceedings of the 6th Conference on Analytical Chemistry in Nuclear Reactor Technology, held in Gatlinburg, Tenn., October 1962.

The copper spark method of spectrographic analysis fills the need for a reliable and uncomplicated procedure to complement conventional d-c arc techniques for routine examination of many different types of materials. Some 65 elements can be readily determined by visually comparing a sample spectrum with spectra of stock standard plates. By limiting the weight of material deposited on the electrodes to about 50 μg, interelement effects are minimized and an accuracy of about ±40% obtained. The spectroscopic techniques used in the development of analytical methods and some specific applications are discussed, as well as limitations and possible sources of error. (auth)

15935 GAS-ANALYZING METHOD AND APPARATUS. Karl Georg Guenther (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,075,076. Jan. 22, 1963. Priority date Dec. 12, 1958, Germany.

A method for performing gas analyses in vacuum with the aid of a mass spectrometer is described. Ions of different specific charges are separated by causing them to assume oscillations having amplitudes correlative with their specific charges. The equipment uses a cold ion source and has a gas-inlet duct for connection to the vacuum space under observation. The dimensioning and operation of the ion source and electrode arrangement are described in detail. (M.P.G.)

Inorganic and Physical Chemistry

15936 (AAEC/TM/179) THE CALCULATION OF CRYSTAL AND COUNTER SETTINGS FOR THE COLLECTION OF CRYSTALLOGRAPHIC DATA WITH A COUNTER-DIFFRACTOMETER IN THE EQUATORIAL PLANE. A. W. Pryor and T. M. Sabine (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Jan. 1963. 9p.

Formulas are developed for the angle between any two vectors lying in a plane through the origin of reciprocal space. The application of these formulas for computing the counter and crystal angles for the collection of data with a counter–diffractometer in the equatorial plane is developed, and a suitable computer program, written in FORTRAN without format suitable for an IBM 1620 computer, is described. (auth)

15937 (AEET/CD/4) AN IMPROVED APPARATUS FOR FINE-PARTICLE MEASUREMENT AND GAS-SOLID REACTIONS. V. V. Deshpande, V. D. Damani, and M. D. Karkhanavala (India. Atomic Energy Establishment, Trombay). 1962. 12p.

The basic principles, construction, and use of an apparatus for measurement of particle size by both gravimetric and volumetric methods as well as studies of gas-solid reactions at constant pressure are described. The improved design permits the in situ determination of particle size of the reaction products and conversely permits the study of reaction kinetics of powders of known particle size, without exposure of the material to any undesired atmosphere. (auth)

15938 (AEET/CD/5) THE DETERMINATION OF PARTICLE SIZE OF THORIA POWDERS BY ADSORPTION OF METHYLENE BLUE. M. D. Karkhanavala, V. V. Deshpande, and E. I. Ezekiel (India. Atomic Energy Establishment, Trombay). 1962. 9p.

The dye adsorption method of particle size determination, which is relatively simple and easily adaptable for routine measurements even on a plant scale, yields values that are of the correct order of magnitude as compared to the standard BET method and can be used as a close approximation. The method and results obtained are described. (H.G.G.)

15939 (AERE-M-1130) GENERATION OF TELLURIUM AEROSOLS AND PRELIMINARY FILTRATION EXPERIMENTS. R. A. Stinchcombe (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1963. 31p.

Two methods of preparing Te aerosols have been investigated: (a) the combustion of H_2Te gas in air, and (b) the heating of tellurium metal (Te) or dioxide (TeO_2) in air or nitrogen. The Te was labeled with radioactive Te^{132} to act as a tracer. Aerosol filtration experiments and sampling were carried out at near ambient temperature. With the first method of preparation, ~30% of the Te used was converted to an aerosol which appeared to consist largely of particulates of Te metal in the submicron size range. More than 85% of this aerosol was removed by a high efficiency glass fiber filter, although a small but significant proportion penetrated the filter. The second method also produced aerosols that were chiefly particulate in nature. Heating either the metal or the dioxide in air produced an aerosol which appeared to consist of particulates of TeO_2 in the submicron size range. Heating the metal in nitrogen produced an aerosol of Te metal particles. On heating Te metal in either air or nitrogen, gas concentrations of Te were obtained in the furnace used for heating, corresponding approximately to the saturation vapor pressure of Te as Te_2. Of the aerosol produced by heating the metal or the dioxide in air or nitrogen, the bulk, 50 to 99% was deposited in the furnace and more than 90% of the remainder was removed by a "Millipore" type AA, filter. A charcoal bed removed only about 50% of the Te leaving the furnace. (auth)

15940 (AFCRL-62-929) THE RAISING OF ANGULAR MOMENTUM DEGENERACY OF f-ELECTRON TERMS BY CUBIC CRYSTAL FIELDS. K. R. Lea, M. J. M. Leask, and W. P. Wolf (Oxford Univ. Clarendon Lab.). Jan. 1962. Contract AF61(052)-125. 30p. (AD-298739)

The effect of a cubic crystal field hamiltonian containing both fourth and sixth degree terms and acting on an angular momentum J was investigated as a function of the ratio between the fourth and sixth degree terms. Tables of eigen-

vectors and diagrams of eigenvalues, expressed as a function of a mixing parameter, are given for all J-manifolds between 2 and 8 in half-integral steps. The application of the results to the magnetic properties of rare earth ions in cubic environments is discussed. (auth)

15941 (AFCRL-62-945) INVESTIGATION INTO THE ORIGIN OF CRYSTALLINE ELECTRIC FIELD EFFECTS ON RARE EARTH IONS. I. CONTRIBUTION FROM NEIGHBOURING INDUCED MOMENTS. Technical Note No. 12. M. T. Hutchings and D. K. Ray (Oxford Univ. Clarendon Lab.). Aug. 1962. Contract AF61(052-125). 33p.

In order to determine how far it is possible to account theoretically for crystalline electric field parameters of rare earth ions a comparison was made between the experimentally determined parameters of Pr^{3+} in $PrCl_3$ and $PrBr_3$ and those calculated on a simple ionic model. A general expression for the contribution of induced moments of any order of neighboring ions to the crystalline electric potential at the rare earth site is given, and this was used to evaluate the contribution of point charges, induced dipoles, and induced quadrupoles to the crystalline electric potential at the Pr^{3+} site in $PrCl_3$; and of point charges, and induced dipoles to the crystalline electric potential at the Pr^{3+} site in $PrBr_3$. The importance of the contribution of the induced moments to the potential is shown, but there are still some large discrepancies between calculated and experimental values. Possible reasons for these are discussed. (auth)

15942 (ARF-1184-8) MAGNETIC PROPERTIES OF INSULATORS. Quarterly Report No. 8, November 16, 1962 to February 15, 1963. Jordan J. Markham (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Mar. 1, 1963. Contract AT(11-1)-578. 32p.

Due to questions raised by divergences noted in ratios of the maximum K-band absorption to the maximum F-band absorption in KCl, an attempt was made to determine if the K to F ratio is a constant. Data taken for γ-irradiated and additively colored RbCl are displayed and discussed. The K to F ratio is concluded to be not constant, indicating that the K-band is not a transition of the F electron to higher states as was previously suspected. The K ratio was also found independent of the M-center concentration, nor was there any apparent influence of the K_1-band on the ratio. The ratio was also found independent of the F-center concentration, and its deviation was noted to have no influence on the parameters characterizing the F-center. Proposed measurements of properties of the F-center luminescence are described. Experimental and theoretical determinations of the lifetime of the F-center in KCl are presented, and the divergence between the experimental and theoretical values is discussed. 24 references. (D.C.W.)

15943 (ARF-1193-20) SCINTILLATION SPECTROMETER MEASUREMENTS OF CAPTURE GAMMA RAYS FROM NATURAL ELEMENTS. Quarterly Report, November 1, 1962 to January 31, 1963. R. C. Greenwood, J. H. Reed, and R. D. Kolar (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Feb. 27, 1963. Contract AT(11-1)-578. 63p.

Thermal neutron capture gamma ray spectra of naturally occurring elements, in both the low and the high energy spectral regions, using NaI(Tl) scintillation crystals as detectors is presented. Such a compilation of spectra will aid in the evaluation of possible practical applications of neutron-capture gamma-ray techniques. An external beam from the ARF research reactor is being used as the source of thermal neutrons for the measurements. Efforts were continued to obtain both low and high energy neutron-capture gamma spectra for inclusion in the Atlas. Specifically, low energy neutron-capture gamma spectra of B, S, Ca, Cr, Zn, Ge, Sr, Mo, Ru, Pd, Sn, Sb, Te, Ba, Ce, Hf, Os, Pt, and Tl were obtained using the $1\frac{1}{2}$ in. × 1 in. NaI(Tl) scintillation spectrometer and of S, K, Ca, Zn, Sr, Sn, Cs, Ba, and Ce with the 3 in. × 3 in. NaI(Tl) crystal. In addition, high energy capture gamma spectra of S and K were obtained during this quarter using the 3 in. × 3 in. NaI(Tl) detector. (auth)

15944 (AROD-006.7) GASEOUS METABORATES. I. A MASS-SPECTROMETRIC STUDY OF THE VAPORIZATION OF LITHIUM AND SODIUM METABORATE. Interim Technical Report No. 3. Alfred Buechler and Joan B. Berkowitz-Mattuck (Little (Arthur D.) Inc., Cambridge, Mass.). Feb. 1963. Contract DA-19-020-ORD-5584. 27p.

The vaporization of lithium and sodium metaborate was studied mass-spectrometrically. The vapors of these compounds consist principally of the monomers $LiBO_2$ and $NaBO_2$, with some dimer and a very small amount of trimer also present. Heats of vaporization of the two metaborates and of boron oxide were determined with an effusion cell designed to give reliable second-law heats. The values obtained are: for $B_2O_3(l) = B_2O_3(g)$ —$\Delta H_{v,1300} = 93.6 \pm 3$ kcal mole^{-1}; for $LiBO_2(c) = LiBO_2(g)$ —$\Delta H_{s,1060} = 79 \pm 3$ kcal mole^{-1}; for $LiBO_2(l) = LiBO_2(g)$ —$\Delta H_{v,1180} = 70 \pm 3$ kcal mole^{-1}; for 2 $LiBO_2(g) = Li_2(BO_2)_2(g)$ —$\Delta H_{1120} = -67 \pm 3$ kcal mole^{-1}; for $NaBO_2(s) = NaBO_2(g)$ —$\Delta H_{s,1070} = 73 \pm 3$ kcal mole^{-1}; and for 2 $NaBO_2(g) = Na_2(BO_2)_2(g)$ — $\Delta H_{1070} = -53 \pm 3$ kcal mole^{-1}. The composition and the dimerization energies of the metaborate vapors resemble those of the alkali halides, hydroxides, and cyanides. (auth)

15945 (AROD-006.8) GASEOUS METABORATES. II. INFRARED SPECTRA OF ALKALI METABORATE VAPORS. Interim Technical Report No. 4. Alfred Buechler and Edward P. Marram (Little (Arthur D.) Inc., Cambridge, Mass.). Feb. 1963. Contract DA-19-020-ORD-5584. 21p.

The infrared spectra of gaseous lithium, sodium, and cesium metaborate were examined between 2500 and 225 cm^{-1}. Bands were observed at 1935 and 600 cm^{-1} for $LiBO_2$, Li^6BO_2, $NaBO_2$, and $CsBO_2$ and at 2000 and 610 cm^{-1} for $LiB^{10}O_2$, $NaB^{10}O_2$, and $CsB^{10}O_2$. The two frequencies were assigned to a stretching and bending vibration, respectively, of the metaborate BO_2 group. Their similarity to the corresponding frequencies of the ion BO_2^- suggests a bond structure of the form $\dot{M}(0^- - B^+ - 0^-)$ for the alkali metaborates. The variation of the bonding of the BO_2 group in a series of related compounds and the absence of alkali-anion stretching frequencies from the spectra of both alkali metaborates and cyanides are also discussed. (auth)

15946 (CEA-2238) ÉTUDE DU PLUTONIUM PAR SPECTROSCOPIE À HAUTE RÉSOLUTION: CONTRIBUTION À LA CLASSIFICATION DU SPECTRE D'ARC ET DÉTERMINATION DU MOMENT MAGNÉTIQUE DE ^{239}Pu. (Study of High-Resolution Spectroscopy of Plutonium. Part I. Contribution to the Classification of the Arc Spectrum. Part II. Determination of the Magnetic Moment of Pu^{239}). Simon Gerstenkorn (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 51p.

Thesis submitted to Université, Paris.

The study of the hyperfine structure and isotope shift enabled the positions of the first five levels of the multiplet $^7F_{0-6}$ belonging to the fundamental configuration $5f^67s^2$ to be

determined. The classification of the arc spectrum begun in this way led to 25 odd levels, the number of classified lines (70) representing about 30 p. 100 of the light emitted by this hollow cathode in the visible. In addition, the isotope shifts of many lines and the data given by the King furnace show that the first levels of the configuration $5f^46d7s^2$ are also low less than 8000 cm^{-1} above the fundamental level $^7F_0$. The proximity of the configuration f^6s^2 and f^6ds^2 shows that the bonding energies of the 5f and 6d electrons are of the same order of magnitude and this fact must be responsible for the multiple valencies belonging to plutonium. From the hyperfine structure of spark lines (Pu II) the interval factor a_f for the electron was deduced giving for the calculated nuclear moment of ^{239}Pu a value of +0.21 ±0.06 μ_N. The position of the hyperfine components show that the nuclear moment is positive, although the theoretical value given by B. R. Mottelson and S. Nillson is negative and equal to $-0.1\ \mu_N$. (auth)

15947 (DRI-2088) INTERMEDIATE-TEMPERATURE OXIDATION OF BERYLLIDES. Quarterly Progress Report. Frank C. Perkins (Denver. Univ. Denver Research Inst.). Mar. 11, 1963. Contract AT(11-1)-1092. 17p.

Results of a study of the oxidation kinetics and characteristics of $ZrBe_{13}$, Zr_2Be_{17}, $NbBe_{12}$, and Nb_2Be_{17} in the temperature range 1200 to 1800°F are presented. These compounds are being considered for nuclear applications because of their atomic properties in combination with outstanding mechanical strength and oxidation resistance at temperatures above 2000°F. However, studies indicate that these beryllides are subject to catastrophic oxidation when exposed to oxidizing atmospheres at the intermediate temperatures below 2000°F. The principal techniques employed in this study include metallography, x-ray diffraction, and thermogravimetric measurements under different atmospheres. (H.G.G.)

15948 (LA-2836) THE SYNERGISTIC EFFECT OF THORIUM ON THE DISTRIBUTION COEFFICIENTS OF SEVERAL ELEMENTS WITH ANION-EXCHANGE RESIN FROM 7M NITRIC ACID. D. B. James (Los Alamos Scientific Lab., N. Mex.). Jan. 21, 1963. Contract W-7405-eng-36. 17p.

Trace-level loading, volume distribution coefficients of silver(I), cerium(III), cobalt(II), chromium(VI), cesium(I), europium(III), mercury(II), palladium(II), scandium(III), yttrium(III), and zinc(II) between 7M nitric acid-thorium nitrate solution and Dowex 1X4(50–100)NO_3^- were measured with the resin loaded to varying degrees with thorium. A theoretical treatment of the data indicated the presence of a thorium-resin-trace element interaction within the resin phase. Calculations showed that the separation factors between thorium and these elements may be much less than expected from individual trace-level loading measurements if a column separation operation were conducted using a thorium feed concentration of several grams per liter. (auth)

15949 (LADC-5374) AN IMMERSION SPECTROPHOTOMETRIC METHOD OF OBTAINING THE REFRACTIVE INDICES OF THIN INTERFERENCE FILMS: FLUORIDE FILMS ON URANIUM DIOXIDE. W. P. Ellis (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract W-7405-eng-36. 17p.

A simple and direct way of measuring the refractive indices of thin interference films in situ on solid substrates is presented. The spectrophotometric absorption peak heights are measured with the specimen immersed in various fluids. The plot of peak height versus index of refraction of the immersion medium is a smooth line going through zero at the refractive index of the interference layer. The mathematical basis of the method is developed and data obtained for F films on UO_2 are presented. (auth)

15950 (LADC-5566) COMPOUNDS OF DIVALENT LANTHANIDES. PREPARATION, OPTICAL PROPERTIES, AND CRYSTAL STRUCTURE. L. B. Asprey, F. H. Ellinger, and E. Staritzky (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 9p.

Preparation of the sulfates, carbonates, and fluorides of divalent samarium, europium, and ytterbium is described. Crystallographic data from both x-ray and optical examination of the compounds are presented. Due to the instability of these plus (II) salts, the precision of the measurement is affected, but sufficient for characterization. A simple and convenient electrolytic method was devised to prepare the divalent sulfates. By metathetical reactions, carbonates and fluorides were prepared. The compounds were analyzed by a pyrohydrolytic method. (H.G.G.)

15951 (LADC-5579) THE PREPARATION AND THERMAL DECOMPOSITION OF SOME RARE EARTH CARBONATES. Earl L. Head and Charles E. Holley, Jr. (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 8p.

The preparation of the carbonates of lanthanum, cerium, praseodymium, neodymium, samarium, europium, and gadolinium by precipitation from homogeneous solution is described. Trichloroacetic acid is used as the source of the carbonate ion. In order to obtain the theoretical ratio of carbonate ion to rare earth ion, in general, it is necessary that the reaction be carried out under a pressure of carbon dioxide. The thermal decomposition of these compounds in vacuum, water vapor and carbon dioxide was studied with an automatic recording vacuum thermobalance. The course of the respective decompositions is shown by the pyrolysis curves. They may be described as follows: $M_2(CO_3)_3 \cdot xH_2O \rightarrow M_2(CO_3)_3 \rightarrow M_2O_2CO_3 \rightarrow M_2O_3 \cdot yCO_2 \rightarrow M_2O_3$ where x varies from compound to compound and the composition $M_2O_3 \cdot yCO_2$ ($y < 1$) is not always observed. Cerium carbonate is a special case. (auth)

15952 (LADC-5711) THE T_{52} He^3 TEMPERATURE SCALE. I. NEW VAPOR PRESSURE COMPARISONS. S. G. Sydoriak and R. H. Sherman (Los Alamos Scientifc Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 51p.

A comparison of He^3 and He^4 vapor pressures, (P_3, P_4), has been made in an apparatus designed to reduce the number and magnitude of corrections associated with the refluxing film in the He^4 pressure sensing tube and the attached bulb. The critical pressure of He^3 has been redetermined to be at 877.0 ± 1.5 mm Hg at 0°C and standard gravity; the corresponding temperature as measured by a He^4 thermometer is 3.3240°K on the 1958 He^4 scale. These (P_3, P_4) comparisons and the T_{58} scale are the basis of the T_{62} He^3 temperature scale to be derived and evaluated in future work. Empirical interpolation equations containing only P_3 and P_4 are described by means of which existing P_4 measurements may be converted to an equivalent P_3. A comparison has been made between this one-step interpolation and a two-step conversion in which the T_{58} and T_{62} scales are used as an interpolation parameter. Deviations between the two procedures are within the estimated errors of the (P_3, P_4) measurements. (auth)

15953 (NASA-TN-D-1523) OPTICAL PROPERTIES OF SATELLITE MATERIALS — THE THEORY OF OPTICAL AND INFRARED PROPERTIES OF METALS. (Na-

tional Aeronautics and Space Administration. George C. Marshall Space Flight Center, Huntsville, Ala.). Mar. 1963. 253p.

The probable effects of solar radiation, primary cosmic rays, van Allen radiation, and meteoric dust on the emissive properties of materials are reviewed. Experimental data on the spectral emittance (0.25 to 27 μ) of metals with polished and carefully abraded surfaces are presented. A quantum mechanical theory of optical and infrared dispersion in metals is combined with other existing theories of Umklapp and impurity scattering processes and is shown to successfully account for the optical properties of metals in the entire free electron region at all temperatures of interest. Detailed calculations are presented for monovalent and some polyvalent metals for which assumption of a symmetric Fermi surface is valid. Calculations of the absorption properties of super-conducting metals are presented in an effort to determine the extent to which bulk electron-phonon processes are responsible for infrared absorption by super-conductors. (H.G.G.)

15954 (PG-Report-352) ANALYTICAL METHOD FOR THE DETERMINATION OF POROSITY AND DENSITY OF MASSIVE LITHIUM ALUMINATE OR BERYLLIA. (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 5p.

The sample is vacuum dried, weighed in air, and then vacuum impregnated with kerosene or other suitable liquid. The sample is weighed in the liquid and then finally in air, when just wet with the impregnation liquid. The lithium aluminate or beryllia should be in the form of pellets, rod or tube, etc., and samples examined should preferably weigh at least 10 g. For a 10 g sample, density is determined to within ±1% relative and porosity to ±10% relative or ±0.1% absolute, whichever is the greater. (auth)

15955 (PWAC-378) THE THERMAL DECOMPOSITION OF URANIUM MONOCARBIDE. P. A. Vozzella, A. D. Miller, and M. A. DeCrescente (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown). Jan. 15, 1962. Contract AT(30-1)-2789. 52p.

The thermal stability of UC was investigated using a modified Langmuir vapor pressure technique. Uranium monocarbide vaporized congruently over the range 2010 to 2230°C. At 2175°C, the congruently vaporizing composition was $UC_{1.1}$. The dominant mode of vaporization in the temperature range studied was $UC_{1.1} \rightarrow U(g) + 1.1\ C(g)$. The vaporization rate in a high vacuum environment ranged from 2.0×10^{-6} g/cm^2-sec at 2010°C to 38.3×10^{-6} g/cm^2-sec at 2230°C. The pressure of U over UC varied ~ linearly from 1.3×10^{-7} atm at 2010°C to 26×10^{-7} atm at 2230°C, while the carbon pressure varied from 0.3×10^{-7} to 6.4×10^{-7} over the same range. The free energy change for vaporization in the range 2010 to 2230°C may be expressed as $\Delta F = 306{,}000 - 65T$ (±35 Kcal/gfw). The heat of vaporization of UC at 298°K is 324.6 ± 2 Kcal/gfw. The standard heat of formation of $UC_{1.1}$ at 298°K is −19.4 ± 2.0 Kcal/gfw. (auth)

15956 (TID-16340) LATTICE POINT DEFECT CONFIGURATIONS INCLUDING THEIR DEPENDENCE ON ELECTRON REDISTRIBUTION. Technical Report No. 31. K. H. Bennemann (Illinois. Univ., Urbana). July 1962. Contract AT(11-1)-182. 22p.

The equilibrium state of the lattice-containing impurities, interstitials, and vacancies was determined using a variational approach minimizing the energy of the crystal with respect to the positions of the ions, impurities, and interstitials. The effect on the lattice distortion arising from the redistribution of electrons is considered. The electrons are treated using the Hartree-Fock approximation. (auth)

15957 (TID-16387) USE OF SULFAMIC ACID FOR DISSOLVING PLUTONIUM. W. J. Jenkins (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Aug. 1962]. Contract AT(07-2)-1. 3p.

Plutonium metal dissolves readily in sulfamic acid and sulfamic-nitric acid mixtures. The use of 1.7 M sulfamic acid for Pu dissolution eliminates the need for platinum-lined equipment which was required to contain HNO_3–HF mixtures formerly used. If solutions are not adequately cooled during dissolution, the reaction ceases abruptly as a result of decomposition of the sulfamate. With proper cooling to prevent decomposition of sulfamate (temperature maintained below 40°C), the reaction in 1.7 M NH_2SO_3H proceeded to essentially complete exhaustion of the hydrogen ion, with very little sludge formation. Sludge, which is a mixture of plutonium oxide and plutonium sulfate, appears in larger quantities if HNO_3 is present. (H.G.G.)

15958 (TID-16476) CONTROL OF HYDRIDE ORIENTATION IN ZIRCALOY. M. R. Louthan, Jr., and R. P. Marshall (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Aug. 1962. Contract AT(07-2)-1. 29p.

Experiments were conducted to find the cause of adverse hydride orientation in the Zy-2 cladding of failed irradiated UO_2 fuel tubes. It was shown that oriented hydride platelets were produced in Zy-2 by the application of stress during hydride precipitation and by deformation prior to hydride precipitation. (auth)

15959 (TID-18140) URANIUM–OXYGEN BONDING IN ALKALI METAL URANATES. Henry R. Hoekstra (Argonne National Lab., Ill.). Dec. 1962. Contract [W-31-109-eng-38]. 6p. (UAC-7138)

The results of an investigation of the applicability of Badger's rule for the determination of uranyl bond lengths in alkali metal uranates are presented. Effective force constants (FeH) and bond lengths (R_{uo}) were calculated for three types of uranates as follows: diuranates – F_{eff} = 5.5 millidynes/Å, R_{uo} = 1.79Å; monouranates – F_{eff} = 4.3 millidynes/Å, R_{uo} = 1.84Å; and orthouranates – F_{eff} = 2.8 millidynes/Å, R_{uo} = 1.99Å. Bond length increases as the bond strength decreases. (H.G.G.)

15960 (TID-18146) OPTICAL ABSORPTION OF COLOR CENTERS IN LITHIUM FLUORIDE CONTAINING MAGNESIUM ADDITIVE. F. Pilcher, D. Schinke, and R. J. Friauf (Kansas. Univ., Lawrence). [1962]. Contract AT(11-1)-1197. 15p.

An absorption band appears when LiF containing small amounts of Mg is irradiated by γ rays. This band is very broad, extending from the F band out to 600 mμ, and is somewhat unstable thermally at room temperature. It appears when the Mg ions are precipitated as well as when they are dispersed, although the behavior is slightly different in the two cases. An interpretation in terms of F_2^- molecules stabilized by proximity of Mg ions is given. When LiF containing Mg is irradiated by neutrons at 350°C, a band peaking near 225 mμ is observed in place of the F band. This band is similar to a band previously reported at 222 mμ by several workers, but these experiments show that its occurrence is definitely associated with the presence of magnesium. It is tentatively suggested that this band may be a Z band, analogous to Z bands in, e.g., KCl : Sr. (auth)

15961 (TID-18198) THE HYDROGEN FLUORIDE SOLVENT SYSTEM. X. A POLAROGRAPHIC STUDY OF

THE $Cu(Hg)_1-Cu(H_2O)_p^{++}$. A. F. Clifford and E. L. Vetor (Purdue Univ., Lafayette, Ind.). [1962]. Contract AT(11-1)-620. 18p.

A polarographic study of the $Cu(Hg)_1-Cu(H_2O)_p^{++}$ couple in liquid hydrogen fluoride was made using a flowing mercury electrode system. The half-wave potentials increased negatively with increasing water concentration through a range of 0.8 to 5.55 molar. A coordination number of two was calculated for the aquocupric complex based primarily on the relationship between the changing ionic strength of the polarographic solutions and the half-wave potentials. (auth)

15962 (TID-18199) HYDROGEN FLUORIDE SOLVENT SYSTEM. XI. IRON PENTACARBONYL–HYDROGEN FLUORIDE SYSTEM AND NUCLEAR MAGNETIC RESONANCE STUDIES OF TRANSITION METAL CARBONYLS. A. F. Clifford and M. D. Campbell (Purdue Univ., Lafayette, Ind.). [1962]. Contract AT(11-1)-620. 19p.

Iron pentacarbonyl was shown to be protonated on the Fe when dissolved in liquid HF. The sharpness of the proton resonance peak of the $Fe-H_2$ bond is dependent on both temperature and acidity of the solvent. The iron pentacarbonyl in liquid HF was shown to be stable for months. Chloride and bromide ions were shown to change the color of the $Fe(CO)_5$–HF solution with evidence for complexes of the type $[HFe(CO)_4^+]_yX^-$, where $y = 1-4$, is presented. The iodide ion reacts with $HF-Fe(CO)_5$ to form $Fe(CO)_4I_2$. Proton magnetic resonance data are given for a variety of carbonyls and substituted carbonyls in addition to iron pentacarbonyl. (auth)

15963 (TID-18200) HYDROGEN FLUORIDE SOLVENT SOLUTION. XII. PROTON MAGNETIC RESONANCE OF THE WATER–HYDROGEN FLUORIDE SYSTEM. A. F. Clifford and M. D. Campbell (Purdue Univ., Lafayette, Ind.). [1961]. Contract AT(11-1)-620. 10p.

The proton chemical shift of water–HF (0 to 100% HF) is reported. The equilibrium constant $[H_3O^+][F^-]/[H_2O]$ was calculated from these data to be 0.22. A maximum in the chemical shift was found at 0.72 mole fraction of HF, as is also true of conductivity and density. Comparison of the chemical shift with the Hammett acidity function of the system as well as with density is made. (auth)

15964 (TID-18263) A GENERAL EQUATION FOR THE CURRENT-POTENTIAL RELATIONSHIPS AT A ROTATING DISC ELECTRODE. Report No. 76. Ilana Fried and Philip J. Elving (Michigan. Univ., Ann Arbor. Dept. of Chemistry). Feb. 8, 1963. Contract AT(11-1)-1148. 23p.

Equations are derived for the complete current-potential relation, the limiting current, and the total current flow for voltammetry at a rotating disc electrode involving a reversible system, in which both the oxidized and reduced species are soluble, and the bulk solution concentration remains constant. The treatment used in the derivation is general, i.e., does not presuppose any particular mechanism for the electrode reaction, and is equally valid for reduction and oxidation processes. The basic equations derived, that express the current as a function of potential and time for any values of the latter two, represent the first solution for the variation of the current at a rotating disc electrode at a point other than that at which the limiting current is observed. These equations can be extended to other types of agitation and to other electroanalytical methods where the assumptions involved are valid. (auth)

15965 (TID-18273) TECHNICAL PROGRESS REPORT NO. 2190 [ON TRANSPORT NUMBER MEASUREMENT]. (New York Univ., New York). Jan. 7, 1963. Contract AT(30-1)-1938. 12p.

The method for determination of transport number of a metal in a salt of that metal by following the change in the center of gravity of a bubble cell is being tested. Equations necessary for calculation of the transport number were derived. Apparatus for the test include: furnace, balance, cell, and d-c and a-c supplies. (M.C.G.)

15966 (NP-tr-958) SPECIFIC RATE OF OXIDATION IN AIR AND CARBON DIOXIDE OF VARIOUS PURIFIED GRAPHITES. F. M. Lang. Translated by J. Roberts (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Compt. Rend., 255: 1511-13(1962). 7p. (Handwritten MS. copy).

In the chemical regime, the specific rates of oxidation by dry gases (air and CO_2) of graphites of very diverse origins, after purification, are essentially the same. The degree of graphitization does not appear to play an important role in the phenomena. The introduction of moisture into the air leads to catalytic action, negative or positive depending on degree of porosity of the solid. (auth)

15967 (SCL-T-468) EXCERPTS FROM INVESTIGATIONS OF THE INFLUENCE OF ATOMIC ADMIXTURES ON THE THERMAL CONDUCTIVITY IN A CRYSTALLINE LATTICE. E. D. Devyatkova and L. S. Stil'bans. Translated by Marcel I. Weinreich (Sandia Corp., Albuquerque, N. Mex.) from Zh. Tekhn. Fiz., 22: 968-72(1952). 7p.

Results obtained from investigations of the influence of atomic admixtures on the thermal conductivity in a crystalline KCl lattice permits the following conclusions: (1) the disruptions of the KCl lattice, occurring as a result of coloring, increase the thermal resistance of the crystal by several % (in the presence of color center concentrations from 0.5 to 5.10^{18}), (2) the magnitude of the variation of thermal resistance is of the same order at 25, −73, and −175°C, and (3) at room temperature, a definite law-like regularity of the variations of thermal resistance as a function of color center concentration was obtained. (H.G.G.)

15968 FIXATION OF RADIOACTIVE ELEMENTS BY MINERAL COALS AND THE NATURE OF THE URANIUM-BOND. István Jurcsik, Endre Upor, Jenö Hohmann, and Sándor Juhász. Acta Chim. Acad. Sci. Hung., 35: 225-32 (1963). (In Russian)

In connection with the enrichment of radioactive elements on mineral coals, the nature of the bond between uranium and humic acid was subjected to a thorough investigation. By means of ion exchange, conductivity titration, and electrophoresis it was proved that the connection between uranium and humic acid must be considered as an actual complex bond. (auth)

15969 CONTRIBUTION TO THE STUDY OF THE CARBONATE COMPLEXES OF URANIUM. I. NEW REACTION OF URANYL HYDROXIDE WITH CARBONIC ACID AS INTERMEDIATE STEP IN OBTAINING URANYL CARBONATE. J. A. Pérez-Bustamante, J. Bermúdez Polonio, and R. Fernández Cellini (Junta de Energia Nuclear, Madrid). Anales Real Soc. Espan. Fis. Quim. (Madrid), Ser. B, 58: 677-704(Nov. 1962). (In Spanish)

A new reaction was found by passing CO_2 through an aqueous suspension of a particularly reactive form of UO_3. The reaction leads to the whole dissolution of the suspended dihydroxiuranyl through complex formation. The process was submitted to careful investigation by proper selection of different instrumental techniques. A theoretical treatment of the question is laid down to account for the variety of phenomena observed, in connection with the most

recent aspects on the chemistry of uranium in solution. The existence of a complex uranyl carbonate compound, showing a CO_3 : U relation equal to 1 is postulated. The stability of the llevow complex solutions is but limited, solid products precipitating therefrom after elapsing a definite time interval. In dilute solution, the complex compound seems to tend irreversibly toward a dinuclear structure, in more concentrated solution toward a tetranuclear arrangement. Both processes, leading to uranyl carbonate complexes with CO_3 : U relations 1 : 2 and 1 : 4 respectively, are presumably governed by a "cores + links" type of mechanism. (auth)

15970 THE REFLECTANCE SPECTRA OF METALLIC OXIDES IN THE 300 TO 1000 MILLIMICRON REGION. F. Vratny and J. J. Kokalas (Purdue Univ., Lafayette, Ind.). Appl. Spectry., 16: 176-84(1962).

The reflectance spectra of forty metallic oxides and oxide-like materials were obtained in the spectral region from 300 to 1000 millimicrons. The data are discussed in relation to the electronic structure of the materials. (auth)

15971 THE TERNARY SYSTEM IRON–PHOSPHORUS–COLUMBIUM. Rudolf Vogel and Wolfgang Bleichroth. Arch. Eisenhuettenw., 33: 195-210(Mar. 1962). (In German)

An experimental investigation was made on phase equilibria in the Fe–FeP–Nb portion of the ternary Fe–P–Nb phase diagram by microscopic, x-ray, and magnetic techniques and by thermal analysis and theoretic investigation of the FeP–NbP_2–Nb portion. (Rev. Metal Lit., 19: No. 6, 1962)

15972 THE TRANSPLUTONIUM ELEMENTS. [PART] II. W. Kraak. Atoomenergie Haar Toepassingen, 5: 1-10 (Jan. 1963). (In Dutch)

The chemical separation methods and the properties of the heaviest elements of the periodic system, Am, Cm, Bk, Cf, Es, Fm, and Md were described. (tr-auth)

15973 THE PHASE INVERSION OF VARIOUS ZrO_2 SAMPLES. I. Hinz and A. Dietzel (Max-Planck-Institut für Silikatforschung, Wurzburg, Ger.). Ber. Deut. Keram. Ges., 39: 489-94(Oct. 1962). (In German)

The inversion monoclinic ⇌ tetragonal zirconia was studied. Hysteresis of the inversion was not diminished by mineralizers. If the sample is kept for some length of time 30 to 40° below the inversion temperature, then the temperature for the beginning of the inversion is raised by 20°. Upon cooling, remnants of the tetragonal modification are still found a few degrees below 700°C. The reduction of ZrO_2 or the presence of SO_3-impurities lower the inversion range. (auth)

15974 THE PHASE BOUNDARIES OF CUBIC SOLID SOLUTIONS OF ZrO_2 AND MgO FROM 1800°C TO THE MELTING POINT. I. Hinz and A. Dietzel (Max-Planck-Institut für Silikatforschung, Wurzburg, Ger.). Ber. Deut. Keram. Ges., 39: 530-3(Nov. 1962). (In German)

The phase boundaries between the cubic solid solution of ZrO_2–MgO and ZrO_2 lie in the range from 1800°C to the maximum melting point at 7 mole % MgO. The boundary between the same solid solution and MgO is apparently independent of temperature and lies at about 20 mole % MgO. In fused specimens (but not in those formed by a solid-state reaction) with MgO contents above 20%, x-ray interference lines appear, which have not yet been identified. (auth)

15975 ON THE PAPER BY I. HINZ AND A. DIETZEL: THE PHASE BOUNDARIES OF CUBIC SOLID SOLUTIONS OF ZrO_2 AND MgO FROM 1800°C TO THE MELTING POINT. H. Meyer (Max-Planck-Institut für Silikatforschung, Wurzburg, Ger.). Ber. Deut. Keram. Ges., 39: 534(Nov. 1962). (In German)

After completion of the above-mentioned work, a publication by D. K. Smith and C. F. Cline appeared in which the existence of cubic pure ZrO_2 at temperatures above 2285°C was demonstrated. Special experiments, carried out in continuation of the investigation, but incomplete at present, point to the fact that this cubic phase, unstable at room temperature, can be obtained only under extreme cooling conditions. The supposition is presented that, with increasing additions of MgO to ZrO_2, the existence region of the cubic modification is displaced to lower temperatures, whereby the cooling rates necessary to obtain the cubic crystals become increasingly smaller. If the measured course of the field between the tetragonal ZrO_2 and cubic (MgO-containing) mixed crystals obtained by A. Dietzel and H. Tober between 1400 and 1800°C is extrapolated, the transition temperature of the tetragonal into cubic ZrO_2 found by Smith and Cline is obtained. (M.C.G.)

15976 THE RADIATION-INDUCED EXCHANGE REACTION OF OXYGEN ATOMS IN CARBON DIOXIDE. Kozo Hirota, Hideo Terasaki, and Motoyoshi Hatada (Osaka Univ. and Japanese Assn. for Radiation Research on Polymers, Osaka). Bull. Chem. Soc. Japan, 35: 1762-5(Nov. 1962). (In English)

Oxygen exchange of CO_2 induced by beta-ray irradiation was investigated by use of O^{18}. From the decrease of O^{18} amount, the apparent and total values of the exchange reaction, G_{corr} ($-CO_2^{18}$) and G_{total}, were calculated to be 1.72 and 51, respectively. The latter value (51) would be equivalent to the forward reaction, but is shown to be larger than the corresponding value (8.5) in Harteck's experiment. (auth)

15977 THE ABSORPTION SPECTRA OF THE H_2, HD, AND D_2 MOLECULES. IV. COMPARATIVE STUDY OF HETEROGENEOUS PERTURBATIONS BETWEEN THE STATES $B^1\Sigma_u$ (2p) AND $C^1\pi_u$(2p) IN THE MOLECULES H_2, HD, AND D_2. André Monfils (Université, Liège). Bull. Classe Sci., Acad. Roy. Belg., (5) 48: 460-81(1962). (In French)

The heterogeneous perturbations between the levels of the $B^1\Sigma_u^+$ state and the levels of the $C^1\pi_u$ state are computed for the molecules HD and D_2. The constants obtained are compared with each other and with those for H_2. The isotope effect is found analytically. (auth)

15978 THE ABSORPTION SPECTRA OF THE H_2, HD, AND D_2 MOLECULES. V. ISOTOPIC EFFECT OF Λ DOUBLING IN THE $C^1\pi_u$(2p) OF THE H_2, HD, AND D_2 MOLECULES. André Monfils (Université, Liège). Bull. Classe Sci., Acad. Roy. Belg., (5) 48: 482-9(1962). (In French)

The Λ doubling is computed after deperturbation in the case of the $B^1\pi_u$ state for the molecules HD and D_2. The results, as well as those for H_2, are compared with a theoretical formula. (auth)

15979 KINETICS AND MECHANISMS OF EXCHANGE REACTIONS OF OXYGEN ^{18}O WITH OXIDATION CATALYSTS. I. CONTRIBUTION TO THE STUDY OF EXCHANGE WITH VANADIUM PENTOXIDE. P. Jírů and J. Nováková (Inst. of Physical Chemistry, Czechoslovak Academy of Science, Prague). Collection Czech. Chem. Commun., 28: 1-10(Jan. 1963). (In English)

It was found that the exchange of O^{18} between the gaseous phase and lattice oxygen of vanadium pentoxide is not of first order from a certain degree of exchange. (auth)

15980 THE REACTIONS OF CARBON DIOXIDE ON URANIUM. Jean Besson, Guy Feron, and Claude Moreau

(Centre d'Études Nucléaires, Grenoble, France). Compt. rend., 256: 430-2(Jan. 7, 1963). (In French)

The attempts made of applying the Valensi-Carter method to the reaction of carbon dioxide on uranium in powdered form has led to no certain results, because of the fragmentation of the metallic grains. The measurement of the activation energy suggests that the reaction is controlled by the diffusion in a UO_2 oxide layer. (tr-auth)

15981 COMBINED MAGNETO-ELECTRIC DIPOLE TRANSITIONS IN THE SPECTRA OF CRYSTALS OF ALKALI FLUORIDES WITH HEXAVALENT URANIUM. A. A. Kaplyanskii and N. A. Moskvin (Ioffe Inst. of Physics and Tech., Leningrad). Dokl. Akad. Nauk SSSR, 148: 558-61(Jan. 21, 1963). (In Russian)

In order to gain further knowledge about the structure of scintillation centers of MeF–U (Me = alkali metal) crystals and about the multipolarity of the transitions, studies were carried out on the effect of deformation due to uniaxial compression on the low-temperature luminescence spectrum of LiF–U and NaF–U single crystals. Investigation of this piezospectroscopic effect indicated that the centers represent the introduction of the UO_2^{2+} uranyl ion into the MeF lattice, replacing the $F^- - Me^+ - F^-$ structure. The multipole character of the transitions was determined on the basis of magnetic or dipole transitions for many MeF–U lines. The optical transitions of some of the lines were found to correspond to a mixed magneto-electric dipole radiation. The experiments were carried out by subjecting the oriented single crystals to a compression along the symmetry axes at 77°K. The deformation caused a reversed polarized splitting of most of the MeF–U lines. (TTT)

15982 EUXENITE AND PRIORITE—TWO POLYMORPHIC VARIETIES OF $YNbTiO_6$. A. I. Komkov (All-Union Geological Scientific Research Inst., USSR). Dokl. Akad. Nauk SSSR, 148, 679-80(Jan. 21, 1963). (In Russian)

Euxenite and priorite are considered as 2 minerals of varying compositions, containing Y, Nb, Ti, and O; in addition, rare earths, Th, U, Ca, and Fe may also be present in form of isomorphous admixtures. Euxenite is isomorphous with an artificial material $YNbTiO_6$, prepared by sintering the equivalent oxides Y_2O_3, Nb_2O_5, and $2TiO_2$ at 1100°C; priorite is isomorphous with the similar $CeNbTiO_6$, also prepared by sintering. Further study revealed that the mixture having the composition of $YNbTiO_6$ has 2 polymorphic modifications, one corresponding to euxenite, the other to priorite. The artificial priorite was prepared by a hydrothermal method at 350°C, transforming the equivalent oxides into the hydroxide form; the artificial euxenite was prepared by calcining, as mentioned above. There is no true chemical difference, only crystallographic difference between the 2 minerals. There are natural euxenites with Th > U content and priorites with U > Th content. (TTT)

15983 THE CHEMISTRY OF TRANSPLUTONIUM ELEMENTS. F. Weigel (Universität, Munich). Fortschr. Chem. Forsch., 4: 51-137(1963). (In German)

A review of the chemistry of the transplutonium elements Am, Cm, Bk, Cf, Es, Fm, Md, No, and Lw with special regard for preparative investigations of weighable amounts is presented. Production, metallic properties, spectrochemistry, and chemical properties are discussed. (M.C.G.)

15984 CRYSTAL STRUCTURE OF UMOHOITE $[UMoO_6(H_2O)_2] \cdot 2H_2O$. E. S. Makarov and L. I. Anikina (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 1, 15-22(Jan. 1963). (In Russian)

The dimensions of the monocline cell of umohoite are a = 6.32, b = 7.50, c = 57.8 A, β = 94; the space group is $P2_1/c$; z = 16. The structure of umohoite is of a pronounced laminated character. In conformity with the cleavage perpendicularly to the axis z infinite pseudohexagonal stretch almost flat nets of uranium, molybdenum, and oxygen atoms arranged in order. The doubled nets form packets with a composition $UMoO_6(H_2O)_2$. Between the packets are disposed zeolitic water molecules, the quantity of which may change from 0 to $2H_2O$. The general crystal form of umohoite is $[UMoO_6(H_2O)_2]-2H_2O$. In the umohoite structure molybdate anions MoO_4^{2-} are lacking. The coordination of oxygen atoms around the uranium and molybdenum atoms is quite similar. This apparently indicates a similar valence state of uranium and molybdenum in umohoite which at the present time is not possible to estimate without a further more precise definition of interatomic spaces and of the position of water molecules. Uranyl and molybdenyl groups with unsymmetric uranium–oxygen and molybdenum–oxygen spaces are found in umohoite; $O^{2\cdot02A}$, $U^{1\cdot74A}O$, $O^{2\cdot05A}$, and $Mo^{1\cdot80A}O$. Each uranyl and molybdenyl group is surrounded along the equator by six oxygen atoms in spaces from 2.10 to 2.23 A. The coordination polyhedron of uranium and molybdenum is a slightly distorted hexagonal bipyramide. In uranium-molybdenum-oxygen nets very short spaces of $O_{11} - O_{11}$ = 2.08 – 2.20 A have been observed. (auth)

15985 RARE EARTHS. Frank H. Spedding. Intern. Sci. Technol., 4: 39-46(Apr. 1962).

A review is given on the characteristics and applications, including electron structure, spectral characteristics, physical properties, valence states, radioactivity, superconductivity, and magnetic properties. The formation of rare earth compounds, such as halides, oxides, carbides, nitrides, sulfides, borides, and hydrides is also included. (P.C.H.)

15986 REACTIONS BETWEEN ALKALINE-EARTH SULFATES AND CRISTOBALITE. W. E. Brownell (Alfred Univ., N. Y.). J. Am. Ceram. Soc., 46: 125-8(Mar. 1963).

The decomposition of magnesium and calcium sulfates was measured preliminary to measuring the reactions between alkaline-earth sulfates and cristobalite. Since gaseous sulfur oxides were evolved in the processes, a starch-iodide titration was used to determine the amounts of decomposition and reaction with time. Magnesium sulfate decomposed at temperatures above 900°C, before reaction with cristobalite. Calcium sulfate was found to react with cristobalite previous to thermal decomposition with an accompanying evolution of sulfur dioxide. Strontium and barium sulfates reacted with cristobalite at progressively higher temperatures. The applications of the data to the sulfur problems in the production of clay products are discussed. (auth)

15987 THE REACTIONS OF IODOPENTAMMINECOBALT(III) WITH VARIOUS "ONE-ELECTRON" OXIDATION-REDUCTION REAGENTS. Albert Haim and Henry Taube (Stanford Univ., Calif.). J. Am. Chem. Soc., 85: 495-500(Mar. 5, 1963).

The reaction of $Co(NH_3)_5I^{2+}$ with Ce(IV) perchlorate or sulfate and with Co(III) perchlorate yields, over a wide range of concentrations, almost equimolar mixtures of Co(II) and pentamminecobalt(III). When Ce(IV) perchlorate or sulfate is added to a mixture of $Co(NH_3)_5I^{2+}$ and free iodide ion, the yield of Co(II) is close to 100%. The photochemical decomposition of $Co(NH_3)_5I^{2+}$ at 2537 A to form Co(II) and I_2 proceeds with a quantum yield of 1.94. These results suggest that Ce(IV) reacts with $Co(NH_3)_5I^{2+}$ to give $Co(NH_3)_5OH_2^{3+}$ and iodine atoms, and that iodine atoms react

efficiently with $Co(NH_3)_5I^{2+}$ to yield Co(II) and I_2. The ratio of $Co(NH_3)_5OH_2^{3+}$ to Co(II) formed when $Co(NH_3)_5I^{2+}$ reacts with $Fe(II)-H_2O_2$ mixtures depends upon the concentrations of the three reactants, and yields of Co(II) varying between 65 and 92% were obtained. The reactions of $Co(NH_3)_5I^{2+}$ with O_3 – Fe(II) and $S_2O_8^{2-}$ – Fe(II) mixtures result, at the concentrations used, in yields of Co(II) higher than 90%. These results provide some evidence on the nature of the reaction intermediates present in the three systems, and for the occurrence of a reaction between hydroxyl radicals and $Co(NH_3)_5^{3+}$ to form Co(II) and HOI. An exploratory study with tert-butylhydroperoxide – Fe(II) mixtures indicates that when $Co(NH_3)_5I^{2+}$, $Co(NH_3)_5Br^{2+}$ and $Co(NH_3)_5N_3^{2+}$ react with methyl radicals, reduction of the Co(III) center occurs. It is suggested that the difference in the behavior of iodine atoms, hydroxyl, and methyl radicals on one hand, and Ce(IV), Co(III) on the other, depends on the ability of the external oxidation-reduction reagent to form a bond with the iodine in the coördination sphere of the cobalt complex. (auth)

15988 KINETIC STUDY OF THE H_2POOH-D_2O EXCHANGE BY NUCLEAR MAGNETIC RESONANCE. A. Fratiello and E. W. Anderson (Bell Telephone Labs., Inc., Murray Hill, N. J.). J. Am. Chem. Soc., 85: 519-21(Mar. 5, 1963).

The exchange with D_2O of the phosphorus bonded hydrogens of hypophosphorous acid was studied using a nuclear magnetic resonance technique. Intensity measurements were used to follow concentration changes during the exchange. The rate law for the exchange, which is acid catalyzed, was found to be: rate = $k_1[H_3PO_2]^2 + k_2 \cdot [H_3PO_2][H^+ + D^+]$. The rate constants for the reaction are compared to those determined for the tritium exchange and an isotope effect is discussed. (auth)

15989 ZIRCONIUM CHEMISTRY IN INDUSTRY. Warren B. Blumenthal (National Lead Co., Niagara Falls, N. Y.). J. Chem. Educ., 39: 604-10(Dec. 1962).

A review is given on the preparation and properties of zirconium carbide, zirconium chlorides and fluorides, hydrous zirconia, zirconyl acetate, ammonium zirconyl carbonate, zirconium sulfates, zirconium compounds with organic radicals and the catalytic effects of zirconium compounds in organic reactions, and zirconium compounds in catalysis. The formation of zirconium is briefly discussed. (P.C.H.)

15990 SECONDARY HYDROGEN ISOTOPE EFFECTS. PART I. STRENGTHS OF α-DEUTERATED CARBOXYLIC ACIDS AND AMINES. E. A. Halevi, M. Nussim, and A. Ron (Israel Inst. of Tech., Haifa). J. Chem. Soc., 866-75(Feb. 1963).

The correlation of secondary isotope effects in terms of induction and hyperconjugation was investigated. The rationale for dealing with essentially vibrational phenomena in electronic terms is presented. Potentiometric and spectrophotometric methods are described for measuring small differences in acid and base dissociation constants. It is shown that the strengths both of normally weak carboxylic acids and amines (pK_a or $pK_b \geq 5$) and of very weak bases of the polynitroaniline type are similarly affected by deuteration on an α-carbon atom. The direction of this secondary isotope effect, and its damping through a saturated carbon atom, indicate that effective inductive electron release from C^2H_3 (or C^2H_2) is greater than from CH_3 (or CH_2). The bearing of these results on kinetic secondary isotope effects and their theoretical interpretation is discussed. (auth)

15991 SECONDARY HYDROGEN ISOTOPE EFFECTS. PART II. ASSOCIATION CONSTANTS BETWEEN METHYLBENZENES AND CHLORANIL. E. A. Halevi and M. Nussim (Israel Inst. of Tech., Haifa). J. Chem. Soc., 876-80 (Feb. 1963).

The equilibrium constants of π-complex formation between chloranil and alkylbenzenes follow the sequence: benzene < toluene > ethylbenzene > isopropylbenzene. $[\alpha\text{-}^2H_3]$Toluene and m-$[\alpha\text{-}^2H_3]$xylene both yield association constants with chloranil that are some 7% smaller than those of the corresponding protium compounds. The results are taken as evidence for less effective hyperconjugative stabilization by C^2H_3 than by CH_3 in this system. Secondary isotope effects and the steric and electronic factors affecting the stability of charge-transfer complexes are discussed in the light of the results. (auth)

15992 THE ADSORPTION OF SOME ANIONIC COMPLEXES ON A CATION-EXCHANGE RESIN. H. Irving and G. T. Woods (Univ. of Leeds, Eng.). J. Chem. Soc., 939-44(Feb. 1963).

The distribution coefficient, K_D, was measured for the adsorption of a number of metals on a cation-exchange resin from concentrated aqueous solutions of alkali metal or magnesium halides. With increasing concentration of lithium (or magnesium) iodide the values of K_D for indium first decreased, as expected; then passed through a minimum and increased, although only anionic complexes must have predominated. The anomalous adsorption was less for bromides and still less for chlorides. Replacement of lithium by sodium or potassium also reduced the effect. With zinc and cadmium K_D decreased rapidly and monotonically with increasing halide concentration. With mercury and lithium chloride there was a small increase. Some analytical applications of the effects are suggested. (auth)

15993 METAL COMPLEXES OF N-(2-PYRIDYLMETHYL)IMINODIACETIC ACID. H. Irving and J. J. R. F. da Silva (Univ. of Leeds, Eng.). J. Chem. Soc., 945-52 (Feb. 1963).

N-(2-pyridylmethyl)iminodiacetic acid was prepared and the stoichiometric stability constants of its proton and metal complexes were measured potentiometrically at 20° in a medium of constant ionic strength, $\mu = 0.1$M. The stability order is $Li^+ < Ba^{2+} < Sr^{2+} < Tl^+ < Mg^{2+} < Ca^{2+} < Ag^+ < Mn^{2+} < Fe^{2+} < Cd^{2+} < Pb^{2+} < Zn^{2+}$ for 1:1 complexes. However, 1:2 complexes are formed with Mn^{2+}, Co^{2+}, Cu^{2+}, and Cd^{2+}. The magnitudes of the stability constants are only slightly less than those for corresponding complexes of the much more basic aliphatic analog ethylenediamine-N,N-diacetic acid; possible reasons for this are discussed. (auth)

15994 QUINQUEVALENT COMPOUNDS OF URANIUM. PART III. URANIUM PENTA-ALKOXIDES. D. C. Bradley, R. N. Kapoor, and B. C. Smith (Birkbeck Coll., London). J. Chem. Soc., 1023-7(Feb. 1963).

New uranium penta-alkoxides were prepared from uranium penta-ethoxide by alcohol exchange. Volatilities were measured under reduced pressure, and molecular weights ebullioscopically in benzene. The compounds were compared with penta-alkoxides of niobium and tantalum. Steric effects in binuclear octahedral complexes $M_2(OR)_{10}$ are discussed. (auth)

15995 ANHYDROUS NITRATES OF THE GROUP II METALS. C. C. Addison and A. Walker (Nottingham Univ., Eng.). J. Chem. Soc., 1220-6(Feb. 1963).

Reaction of beryllium chloride with a mixture of dinitrogen tetroxide and ethyl acetate gave the addition compound

$Be(NO_3)_2 \cdot 2N_2O_4$. Thermal decomposition yielded successively beryllium nitrate and beryllium oxide nitrate $Be_4O(NO_3)_6$. Beryllium nitrate is strongly covalent, and is unusual in that it gives nitrite ions as well as nitrate ions on dissolution in water or alkali; possible mechanisms are discussed. By similar reactions with Grignard magnesium, the 1:1 adduct $Mg(NO_3)_2 \cdot N_2O_4$ is obtained. This loses dinitrogen tetroxide irreversibly at 52 to 54°, in contrast to the reversible dissociation of $Cu(NO_3)_2 \cdot N_2O_4$. Calcium, strontium, and barium nitrates form no stable adducts at room temperature. The infrared spectra of all five metal nitrates are reported and discussed. (auth)

15996 EXCHANGE OF CHLORINE-36 OF SOME GROUP III CHLORIDES WITH NITROSYL AND PHOSPHORYL CHLORIDES. J. Lewis and D. B. Sowerby (Univ. of Manchester, Eng. and Nottingham Univ., Eng.). J. Chem. Soc., 1305-8(Feb. 1963).

Complete and rapid exchange of radiochlorine was observed between aluminium, gallium, indium, and thallium(III) chloride and liquid nitrosyl chloride as solvent, in agreement with the conception of the 1:1 addition compounds formed in these systems as nitrosonium compounds. Transfer of radioactivity in similar systems with phosphoryl chloride as solvent was very slow, except in the presence of added inactive chloride ion. The nature of the species in solution, and possible structures for the addition compounds, $POCl_3 \cdot MCl_3$, are discussed. (auth)

15997 ELECTROMETRIC TITRATIONS OF TRIVALENT CERIUM WITH ALKALI MOLYBDATE. Ram Sahai Saxena and Mohan Lal Mittal (Government Coll., Kota, India). J. Electroanal. Chem., 5: 287-91(Apr. 1963). (In English)

The reaction between Ce^{3+} and MoO_4^{2-} was investigated by electrometric techniques involving amperometric, potentiometric, pH, and conductometric titrations between $Ce(NO_3)_3$ and Na_2MoO_4 solutions at several concentrations in aqueous and aqueous-alcoholic media. The end-points obtained from the sharp breaks and inflexions in titration curves occur at a stage where the molecular ratio of Ce^{3+} and MoO_4^{2-} is 2:3 and correspond to the formation and precipitation of normal cerous molybdate $Ce_2O_3 \cdot 3MoO_3$ in the pH range 5.8 to 6.2. Amperometric titrations yield very accurate results up to 10^{-3} M concentration of $Ce(NO_3)_3$ and offer a simple and rapid method for the determination of trivalent cerium as molybdate. No reference for the study of this reaction by electrometric methods has been found in the literature, although the reaction has provided conclusive results on the composition of other metal molybdates. (Saxena et al.). (auth)

15998 THE MECHANISM OF THE NICKEL–FLUORINE REACTION. R. L. Jarry, J. Fischer, and W. H. Gunther (Argonne National Lab., Ill.). J. Electrochem. Soc., 110: 346-9(Apr. 1963). (TID-16909; UAC-6691)

Investigations were undertaken to elucidate the mechanism of the Ni–F reaction with respect to which species, metal or nonmetal, is the principal migrant through the nickel fluoride scale. Impinging scale and radioactive tracer methods were used. The results obtained for both types of marker experiments indicated that fluorine, rather than nickel, migrates through the fluoride scale during the course of the reaction. It is most probable that the mechanism involves the transport of fluorine through the bulk of the nickel fluoride scale. (P.C.H.)

15999 CONDUCTOMETRIC STUDIES ON THE PRECIPITATION OF SODIUM AND AMMONIUM DIURANATE. M. C. Saxena (Univ. of Saugar, India). J. Indian Chem. Soc., 39: 831-4(Dec. 1962).

The reaction between uranyl nitrate, on the one hand, and sodium or ammonium hydroxide, on the other, was investigated conductometrically by applying the monovariation method. Job's method of continued variation was also found suitable for the study of insoluble sodium diuranate. Complete precipitation occurs at the stoichiometric point and the reverse reaction (sodium hydroxide constant, uranyl ion varying) can be used for the conductometric estimation of uranium in uranyl salts. (auth)

16000 INFRA-RED SPECTRA OF SEVERAL SALTS OF ACIDIC ORGANOPHOSPHORUS COMPOUNDS. J. R. Ferraro (Argonne National Lab., Ill.). J. Inorg. Nucl. Chem., 24: 475-82(Nov. 1962).

The infrared spectra of several sodium salts of acidic organophosphorus compounds $(GO)_2PO(OH)$, $(GO)G'PO(OH)$ (where G can be aryl, alkyl, or mixed alkyl-aryl or a substituted variant) are discussed. It was observed that the salt spectra are sharper than the acid spectra. The phosphoryl absorption (P → O) in the acids were replaced by two new peaks—the POO^- asymmetric vibration (1210 to 1283 cm^{-1}), which is at a higher frequency when the G group is aryl, and the POO^- symmetric vibration (which appears to remain constant for the phosphates at about 1100 cm^{-1}). The position of the POO^- asymmetric vibration for the salts of p-substituted aryl phosphoric acids appeared to shift to higher frequency as the Hammett function σ_p decreased. In the aryl phosphoric acids and the aryl hydrogen phosphonates, the region of about 960 to 1000 cm^{-1} attributed to the [P–O]-aryl vibration disappeared on salt formation, and a new region at 900 to 930 cm^{-1} appeared. In the alkali, alkaline earth, Co(II) and Sc(III) salts of bis-(2-ethylhexyl) phosphoric acid, there appeared to be a trend toward lower values of Δ (where Δ is ν_{POO^-} asymmetric $-\nu_{POO^-}$ symmetric) as ϕ (charge/ionic radii) increased. (auth)

16001 OBSERVATIONS ON THE RARE EARTHS. LXXV. THE STABILITIES OF DIETHYLENETRIAMINEPENTAACETIC ACID CHELATES. T. Moeller and L. C. Thompson (Univ. of Illinois, Urbana). J. Inorg. Nucl. Chem., 24: 499-510(Nov. 1962).

The interaction between diethylenetriaminepentaacetic acid (H_5DTPA or H_5Z) and rare-earth metal ions (Ln^{3+}) was investigated. The acid formation constants of the hydrogen chelates ($LnHZ^-$) and the formation constants of the normal chelates (LnZ^{2-}) were obtained at 10, 20, and 30°C, and an ionic strength of 0.1(KNO_3), the former by a titration technique and the latter by a mercury indicator electrode technique. The data were treated by a least-squares method for evaluation of ΔH^0 and ΔS^0. Although errors in the functions were substantial, the functions were related to observed trends in stability. The dissociation constants for the last three protons of diethylenetriaminepentaacetic acid were measured as a function of temperature at ionic strength 0.1(KNO_3) and converted to thermodynamic functions by least squares analysis. The functions were compared with corresponding values for related chelating agents. (auth)

16002 THE CHEMICAL NATURE OF SODIUM BERYLLATE SOLUTIONS. D. A. Everest, R. A. Mercer, R. P. Miller, and G. L. Milward (National Chemical Lab., Teddington Middx., Eng.). J. Inorg. Nucl. Chem., 24: 525-34 (Nov. 1962).

In sodium beryllate solutions of low Na_2O/BeO ratios, polymeric beryllate anions are present and range from ionic to colloidal dimensions. At high Na_2O/BeO ratios simple beryllate anions are probably present. Addition of silicon (as Na_2SiF_6 or Na_2SiO_3) to beryllate solutions of low Na_2O/BeO ratio causes precipitation of the beryllium as an

x-ray-amorphous phase. Addition of Ca or Sr salts under similar conditions results in the precipitation of crystalline complexes which, it is believed, are derived from polyberyllate anions. (auth)

16003 KINETICS OF THE REDUCTION OF NEPTUNIUM(V) WITH IODIDE ION. N. K. Shastri, J. O. Wear, and E. S. Amis (Univ. of Arkansas, Fayetteville). J. Inorg. Nucl. Chem., 24: 535-40(Nov. 1962).

The rate law for the reaction, $NpO_2^+ + I^- = Np^{4+} + \frac{1}{2}I_2$, may be expressed as $dNp^{4+}/dt = k[NpO_2^+][I^-]^{1.5}[H^+]^{2.5}$. At 25° and in 3.29 M HCl, the rate constant is 10.27×10^{-2} $l.^4 mole^{-4} min^{-1}$. The apparent activation energy is 28300 cal $mole^{-1}$. A possible mechanism is suggested. (auth)

16004 ON THE NATURE OF THE SOLVATED 8-QUINOLINOL AND 2-METHYL-8-QUINOLINOL CHELATES OF THORIUM(IV). W. W. Wendlandt and G. R. Horton (Texas Technological Coll., Lubbock). J. Inorg. Nucl. Chem., 24: 587-8(Nov. 1962).

X-ray studies were made on $Th(MeOx)_4$ and the solvated compounds, $Th(Ox)_4 \cdot HOx$ and $Th(MeOx)_4 \cdot MeOxH$ (where Ox^- is the 8-quinolinolate ion and $MeOx^-$ is the 2-methyl-8-quinolinolate ion). It was found that the d-spacings for the normal and solvated and 2-methyl-8-quinolinol are similar, differing by only 0.01 to 0.03 A for each h k l position. Thus, it was concluded that the solvated and the normal chelate structures are the same and that the solvated chelate is merely a mixture of $Th(MeOx)_4$ and 2-methyl-8-quinolinol. The results are tabulated. (P.C.H.)

16005 A STUDY OF THE MECHANISM OF THE ELECTROLYSIS OF UO_2Cl_2 IN MOLTEN NaCl–KCl EUTECTIC. R. S. Wilks (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 7: 157-64(Nov. 1962). (AERE-R-3833) (In English)

In connection with attempts to grow large single crystals of UO_2, electrolyses of UO_2Cl_2 under various conditions have been carried out and it has been found that the products at the electrodes do not correspond to the deposition of UO_2^{2+} and Cl^- ions only. Several reactions are obviously occurring simultaneously and experiments were performed to isolate and determine these various reactions. From the results of these experiments a reaction mechanism is formulated to explain the observations, and suggestions are made for future attempts to grow single crystals. (auth)

16006 SMALL-ANGLE SCATTERING OF NEUTRONS BY $FeCl_2$ NEAR THE NEEL TEMPERATURE. Ojiro Nagai (Osaka Univ.). J. Phys. Soc. Japan, 18: 74-8(Jan. 1963). (In English)

Slow neutron small-angle scattering cross sections for $FeCl_2$ above but near the Néel temperature are calculated with a method that is an extension of Zernike's theory of propagation of order. The result is compared with experimental data and a reasonable agreement is found if the ratio of the two exchange coupling constants in this crystal is assumed to be about 0.08. (auth)

16007 BINDING OF XENON TO HALOGENS, TO ALKALI METALS, AND TO ITSELF. Leland C. Allen (Princeton Univ., N. J.). Nature, 197: 897(Mar. 2, 1963).

Properties of Xe that influence the binding of Xe to halogens, to alkali metals, and to itself are discussed. It is pointed out that theoretical prediction of inert gas compounds is not adequate. (C.H.)

16008 REMOVAL OF IODINE VAPOUR FROM AIR BY METALLIC COPPER. J. B. Morris, R. A. Stinchcombe, M. D. Gray, and D. H. Logsdail (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Nucl. Energy, 70-3 (Mar. 1963).

The sorption of iodine from air is reviewed, and the thermodynamic and mass transfer aspects of iodine sorption on copper are discussed. Dynamic sorption experiments on copper mesh and silver-plated copper mesh for measuring the mass transfer of iodine from air to solid are reported. (D.L.C.)

16009 RAMAN AND INFRARED SPECTRA OF LIQUID DEUTERATED HYDRAZINE N_2D_4. Yu. I. Kotov and V. M. Tatevskii. Opt. Spectry. (USSR) (English Transl.), 13: 487-8(Dec. 1962).

Infrared absorption and Raman spectra of N_2H_4 and N_2D_4 were obtained. From the respective spectra, values of the vibrational frequencies were derived; frequencies of the fundamental bands of N_2H_4 agree generally with other determinations. (D.C.W.)

16010 PECULIARITIES IN THE SPECTRUM OF MONODEUTEROBENZENE. V. L. Broude and S. M. Kochubei. Opt. Spectry. (USSR) (English Transl.), 13: 494-5(Dec. 1962).

Analysis of the absorption spectra of monocrystals of monodeuterobenzene in polarized light revealed the existence of multiple bands for higher terms of the M-series. This indicates that monodeuterobenzene molecules have C_{2v} symmetry and that the M-series overtones result from the development of two completely symmetric vibrations (920 and 912 cm^{-1}). (D.C.W.)

16011 ZEEMAN EFFECT IN THE ABSORPTION AND LUMINESCENCE SPECTRUM OF $CaF_2:Sm^{++}$ and $SrF_2:Sm^{++}$ CRYSTALS. B. P. Zakharchenya and A. Ya. Ryskin. Opt. Spectry. (USSR) (English Transl.), 13: 501-2(Dec. 1962).

Observation of the magnetic splitting of luminescence and absorption lines of CaF_2 and SrF_2 containing Sm^{2+} ions revealed the orientation of the crystal in the magnetic field to have little effect on the Zeeman effect. Close similarity in values of the g factors for the levels that produce observed triplet splitting indicates that the levels belong to a shielded $4f^6$ configuration. (D.C.W.)

16012 DEFORMATION SPLITTING OF LINES IN THE SPECTRA OF ALKALI-EARTH FLUORIDE CRYSTALS ACTIVATED BY Sm AND Eu DIVALENT IONS. A. A. Kaplyanskii and A. K. Przhevuskii. Opt. Spectry. (USSR) (English Transl.), 13: 508-9(Dec. 1962).

Line splitting observed when alkali-earth fluoride crystals containing divalent Eu and Sm ions were compressed is discussed in terms of splitting observed in spectra of other doped crystals. Splitting in Sm^{2+}-doped crystals showed dependence on the direction of compression and is apparently connected with f-d and f-f transitions. The spectrum of Eu^{2+} in crystals was deemed due to f-d transitions. (D.C.W.)

16013 ON THE DIFFERENCE IN TWO PEAKS OF QUADRUPOLE SPLITTING IN MÖSSBAUER SPECTRA. V. I. Goldanskii, E. F. Makarov, and V. V. Khrapov (Inst. of Chemical Physics, Academy of Sciences, Moscow). Phys. Letters, 3: 344-6(Feb. 15, 1963). (In English)

Two Mössbauer spectral peaks of quadrupole splitting were studied both as a function of triphenylchlorostannane crystal orientation and at two different angles of the γ ray beam. Of three explanations offered for the asymmetry of doublets in the Mössbauer spectra from polycrystalline samples, only the anisotropy of the Mössbauer effect in single crystals seems to be possible. (C.E.S.)

16014 EXPERIMENTAL STUDY OF RELAXATION PROCESSES FOR DIVALENT COBALT IONS. Wesley P.

Unruh and J. W. Culvahouse (Univ. of Kansas, Lawrence). Phys. Rev., 129: 2441-53(Mar. 15, 1963).

The nuclear orientation produced for stable Co^{59} nuclei of divalent cobalt ions in the X site of $La_2Zn_3(NO_3)_{12} \cdot 24H_2O$ by saturation of allowed and forbidden transitions between levels of the hyperfine structure in a strong magnetic field is deduced from measurements of the intensity of allowed transitions while some other transition is saturated. These measurements give more than just the nuclear orientation; and, when combined with transient measurements, permit the values of the many relaxation rates to be deduced. The relaxation rates depend strongly on the direction of the applied magnetic field but can all be predicted rather accurately when an appropriate and reasonable choice is made for the theoretical parameters involved. The temperature dependence of the relaxation rates is of the form $1/(aT + bT^9)$ and, below 2.2°K, the direct process dominates. The most striking effects are the extreme importance of the hyperfine relaxation effects, and a perfect Overhauser effect, producing nuclear alignment opposite in sign from that usually anticipated. (auth)

16015 THE SPECIFIC HEAT OF GADOLINIUM AND YTTERBIUM METALS BETWEEN 0.4 AND 4°K. O. V. Lounasmaa (Argonne National Lab., Ill.). Phys. Rev., 129: 2460-4(Mar. 15, 1963). (TID-17455; UAC-6860)

The heat capacities of gadolinium and ytterbium metals are measured between 0.4 and 4°K in a He^3 cryostat. For gadolinium, anomalous humps are observed in C_p at 1.1, 1.6, and 3.7°K. The ground state of the Gd^{3+} ion is $S^8_{\frac{7}{2}}$ and consequently, as a result of zero orbital angular momentum of the 4f electrons, the nuclear specific heat is small. The observed C_p is much larger than expected for the metal alone; the excess entropy could be attributed to magnetic ordering of Gd^{3+} ions in the Gd_2O_3 impurity (0.54% of oxygen in our sample). The specific heat of ytterbium, between 0.4 and 4°K, can be expressed by $C_p(mj/mole°K) = 1.180T^3 + 2.90T + 0.012T^{-2}$. The lattice specific heat corresponds to a Debye $\theta = 118.1$°K, which is considerably lower than the value $\theta \sim 160$°K observed for other higher rare earths. The electronic specific heat of ytterbium $C_E = 2.90T$ is also much smaller than the usual value $C_E \sim 10T$. In the nonmagnetic ytterbium metal the 5d electron, normally in the conduction band, is added to the 4f shell which thereby becomes full. This explains the differences between the specific heat of ytterbium and of the other rare earths. The small term in C_p proportional to T^{-2}, is probably caused by long-range exchange-type coupling between the electronic moments of rare-earth impurities in the ytterbium sample. (auth)

16016 PARAMAGNETIC RESONANCE SPECTRUM OF GADOLINIUM IN $LaAlO_3$. W. Low and A. Zusman (Hebrew Univ., Jerusalem). Phys. Rev., 130: 144-50(Apr. 1, 1963).

The resonance spectrum of Gd^{3+} in $LaAlO_3$ was investigated as a function of the temperature. It was found that the trigonal parameter b_2^0 changes smoothly from 67×10^{-4} cm^{-1} at 689°K to 491×10^{-4} cm^{-1} at 20°K. The transition to cubic phase is found by the extrapolation to be at 720 ± 15°K. The spin Hamiltonian appropriate to the trigonal phase is given by $H = g\beta H \cdot S + B_2^0O_2^0 + B_4^0O_4^0 + B_6^0O_6^0 + B_4^3O_4^3 + B_6^3O_6^3 + B_6^6O_6^6$. The evaluation of the magnitude of the various parameters B_m^n is presented. (auth)

16017 PARAELECTRIC RESPONSE OF KD_2PO_4. R. M. Hill and S. K. Ichiki (General Telephone and Electronics Labs., Inc., Palo Alto, Calif.). Phys. Rev., 130: 150-1(Apr. 1, 1963).

The dielectric behavior of KD_2PO_4 in the paraelectric region, i.e., above the Curie temperature, was measured up to 3.5×10^{10} cps. For frequencies above the crystal resonances, the complex dielectric coefficient exhibits a relaxation behavior very similar to that observed in triglycine sulfate. A model, which assumes a Gaussian distribution of Debye dipoles, fits the data quite well and appears to establish this representation as a valid one for "soft" ferroelectrics. (auth)

16018 NUCLEAR RELAXATION TIME IN MIXED SODIUM SALTS. J. Grunzweig, D. Zamir, and J. Zak (Israel Inst. of Tech., Haifa). Physica, 29: 50-62(Jan. 1963). (In English)

Reduction of up to 50% was observed in nuclear magnetic resonance measurements of relaxation time T_1 of Na^{23} in mixed, single phase sodium halide crystals. Van Kranendonk's theory of quadrupole nuclear relaxation mechanism, based on the point-charge model, was slightly simplified at $T/\theta \geq 1$, and then applied to this problem. The calculations predict a much smaller reduction. Within the accuracy of the measurements, all relaxation transients show only a single relaxation time present which implies strong spin-spin coupling of all nuclei contributing to the signal, irrespective of the fact that some of its Zeeman levels were shifted by static quadrupolar effects. (auth)

16019 EFFECT OF SMALL ADDITIONS OF OXIDES OF YTTRIUM, LANTHANUM AND CERIUM ON CERTAIN MAGNETIC CHARACTERISTICS OF MAGNESIUM–MANGANESE FERRITES AND THE X-RAY SPECTRA. E. E. Vainshtein, A. I. Gunchenko, B. I. Kotlyar, R. M. Ovrutskaya, and G. A. Shapiro. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 6, 72-80(Nov.-Dec. 1962). (In Russian)

A study was made of the effect of admixtures of La, Ce, and Y oxides on the magnetic characteristics of Mn and MgMn ferrites. The effect differs for various rare earth elements and depends on their content in the ferrite. The fine structure of the x-ray absorption spectra of Fe and Mn in ferrites with various quantities of additions of rare earth elements was investigated. On the basis of an analysis of the experimental data, inferences were drawn as to the possible mechanism of the effect of admixtures on the energetic state of the atoms of the basic components in the ferrites. (auth)

16020 XENON TETRAFLUORIDE: REACTION WITH AQUEOUS SOLUTIONS. Stanley M. Williamson and Charles W. Koch (Univ. of California, Berkeley). Science, 139: 1046-7(Mar. 15, 1963).

Xenon tetrafluoride reacts with water to yield xenon, oxygen, hydrofluoric acid, and a very soluble species containing xenon. Evaporation of the solution yields a white, crystalline substance which was identified as xenon (VI) oxide, XeO_3. (auth)

16021 KRYPTON TETRAFLUORIDE: PREPARATION AND SOME PROPERTIES. A. V. Grosse, A. D. Kirshenbaum, A. G. Streng, and L. V. Streng (Temple Univ., Philadelphia). Science, 139: 1047-8(Mar. 15, 1963).

Kr and F_2 do not react at high temperatures. However, KrF_4 was prepared by electric discharge at low temperatures, using a vessel with copper electrodes. In one experiment, 500 cm^3 of a 1:2 mixture of Kr and F_2 was completely converted to 1.15 g KrF_4 in 4.0 hr; the KrF_4 is deposited on the glass wall of the discharge vessel in the form of a white solid. KrF_4 is much less thermally stable than XeF_4, but it can be stored for weeks at −78°C without decomposing. The vapor pressure, corrected for decomposition, was measured and found to follow the equation $\log_{10} p\ (mm) = 8.531 - 1930/T$; $\Delta H_{subl} = 8840 \pm 300$ cal/mole, and extrapolated sublimation temperature ≅70°C. (D.L.C.)

16022 DEUTERATED WATER EFFECTS ON ACID IONIZATION CONSTANTS. R. Bruce Martin (Univ. of Virginia, Charlottesville). Science, 139: 1198; 1203 (Mar. 22, 1963).

Linear relations of the form $\Delta pK = pK^D - pK^H = a + b\ pK^H$ relating ionization constants of acids in light and heavy water must have the same slope b for any kind of acid unless the previously unconsidered charge type is important or this equation is not valid. (auth)

16023 XENON TETRAFLUORIDE MOLECULE AND ITS THERMAL MOTION: A NEUTRON DIFFRACTION STUDY. John H. Burns, P. A. Agron, and Henri A. Levy (Oak Ridge National Lab., Tenn.). Science, 139: 1208-9 (Mar. 22, 1963).

A neutron-diffraction analysis of the xenon tetrafluoride crystal structure confirmed the square-planar symmetry of the molecule. From the data, the average Xe to F bond length is 1.953 Å (σ = 0.002) and the F to Xe to F angle is 90.0° (σ = 0.1). A description of the thermal displacements in the crystal is given. (auth)

16024 CHLORINATION OF LOPARITE CONCENTRATE. A. S. Berengard, I. E. Vilkomirskii, V. A. Kozhemyakin, T. S. Sedykh, and O. I. Erokhina. Tsvetn. Metal., No. 4, 56-61(Apr. 1962). (In Russian)

Descriptions are given of an improved dry method for loparite concentrate chlorination at 900 to 1000°C. It is shown that chlorination is possible with concentrate containing 35% air and that carbon reduction in coke from 18 to 20 to 12 to 13% reduces the cinder by a factor of 5. (R.V.J.)

16025 A SPECTROSCOPIC STUDY OF SOME RARE EARTH COMPLEXES. Richard Marvin Alire. Thesis, Albuquerque, N. Mex., Univ. of New Mexico, 1962. 166p.

The phenomenon of intramolecular energy transfer was studied using anthranilate, 8-hydroxyquinolate, 2-methyl-8-hydroxyquinolate, and salicylaldehyde rare earth chelates. Line emission characteristic of the rare earth ion was observed whenever the lowest triplet (measured) of the complex was higher in energy than the emitting (resonance) level of the rare earth trivalent ion. The path of energy transfer from the organic portion of the chelate to the rare earth ion was verified as going via the lowest or a nearby triplet state of the complex. Relative quantum yield measurements were made on the anthranilate rare earth series using a photographic method. Gadolinium anthranilate was used as an internal standard with a defined total quantum yield of 1.0. Fluorescence quantum yields varied from 0.04 for ytterbium anthranilate to 0.45 for lutecium and lanthanum anthranilates. Phosphorescence quantum yields varied from 0.037 for ytterbium anthranilate to 0.81 for gadolinium anthranilate with an estimated error of 25%. The relative quantum yields of the anthranilates have no simple relationship to the magnetic susceptibilities of the trivalent rare earth ions. Dissociation and decomposition of the rare earth salicylaldehyde chelates were observed. The salicylaldehyde chelates demonstrate three different types of emission: (i) green phosphorescence (lifetime $\sim 10^{-3}$ sec) attributed to the salicylaldehyde ion, (ii) a yellow phosphorescence with a lifetime of $\sim 10^{-4}$ sec in duration attributed to a triplet to ground state transition in a species containing the metal ion, (iii) a relatively long lived (10^{-1} sec) afterglow attributed to an electronic transition occurring in either SA, solvated SA, or both species. Energy transfer to rare earth ions in salicylaldehyde chelates probably occurs from the excited state measured to be approximately 17,700 cm^{-1}. This level is thought to be present in one or all three of the species $M(SA)_3$, $M(SA)_2^+$, $M(SA)^{++}$. (Dissertation Abst., Vol 23, No. 7)

16026 THE THERMAL DECOMPOSITION OF CESIUM SUPEROXIDE. George Vincent Morris. Thesis, Providence, Univ. of Rhode Island, 1962. 72p.

The thermal decomposition of Cs superoxide was studied in the temperature range 280 to 360°C. The reaction path was established by measuring the dissociation pressure of the oxide over the composition range $Cs_2O_{3.71}$–$Cs_2O_{1.75}$. It was found that the superoxide decomposes directly to the peroxide without intermediate formation of the sesquioxide. Further, it was found that solid solution formation between the superoxide and lower oxides does not result over the range of composition studied. The thermal decomposition of Cs peroxide was studied in the temperature range 300 to 340°C, and equilibrium pressures were obtained for two compositions $Cs_2O_{1.95}$, $Cs_2O_{1.75}$. The over-all mechanism for the decompositions can be illustrated by the following equations: $CsO_2(s) = \frac{1}{2}Cs_2O_2(s) + \frac{1}{2}O_2(g)$ and $Cs_2O_2(s) = Cs_2O(s) + \frac{1}{2}O_2(g)$. The thermodynamic properties ΔF^0, ΔH^0, ΔC_p^0, ΔS^0, and Kp were calculated for both reactions. (Dissertation Abst., Vol. 23, No. 7)

16027 A STUDY OF THE THERMAL ACCOMMODATION OF HELIUM, NEON, ARGON, KRYPTON AND XENON DURING ADSORPTION OF POTASSIUM AND CESIUM ON TUNGSTEN. Donald Vincent Roach. Thesis, Columbia, Mo., Univ. of Missouri, 1962. 135p.

The thermal accommodation coefficient (A. C.) is a measure of the efficiency of energy transfer at a gas-solid interface. The accommodation coefficients of He, Ne, Ar, Kr, and Xe were measured on a W surface as the latter acquired chemisorbed layers of Cs and of K at a steady rate by exposure of the filament to the vapor of these metals at their respective equilibrium pressures. In every case, as the coverage of the tungsten surface increased, the A. C. values increased to a maximum and subsequently decreased, then leveled sharply to a final fixed value, or in some cases went through a shallow minimum to the same final fixed value. These final values of the A. C. were intermediate between the maximum values and the values characteristic of a clean tungsten surface. The contact potential difference change (the negative of the change of the work function) was measured as adsorption of K occurred at one W filament of a vacuum diode at 0.00°C. The work function calculated using an average work function of 4.53 volts for W decreased to a minimum of 2.21 volts with a subsequent increase to a fixed final value of 2.58 volts. The times required to acquire coverages to give the minimum work function and the final fixed value were comparable to the times required to reach the maximum and final fixed value of the A. C. The A. C. of helium was used to identify the change of coverage upon establishment of a steady state between Cs vapor at a pressure of about 5×10^{-10} mm (–37.32°C) and adsorbed Cs at each of several filament temperatures (273°K to 800°K). (M.P.G.)

16028 INFRARED STUDIES OF MAGNESIUM SULFATE AND THORIA: PART I. INFRARED EVIDENCES FOR BISULFATE FORMATION IN THE DEHYDRATION OF MAGNESIUM SULFATE. PART II. INFRARED IDENTIFICATION OF SILICA ADSORBED ON THORIA SURFACES. PART III. A KINETIC STUDY OF SILICA ADSORPTION ON THORIA SURFACES. PART IV. AN INFRARED STUDY OF HYDRATED THORIUM NITRATE. Jong Soo Cho. Thesis, Salt Lake City, Univ. of Utah, 1962. 81p.

I. Infrared, thermogravimetric, and x-ray diffraction studies show that in the dehydration of the monohydrate to the anhydrate form of $MgSO_4$, a hitherto unreported dehydration stage exists. This stage is shown to consist of hydrogen bonded $Mg(HSO_4)_2 \cdot Mg(OH)_2$, and is referred to

as the bisulfate stage. When this bisulfate stage is changed to the anhydrous stage, it is believed the H and OH groups each split off from a bisulfate and a hydroxide to form water in which form it leaves the surface. Removal of these groups leaves the surface in a strained condition which is otherwise essentially unchanged by H and OH removal. These strained sites are receptors of H and OH groups from alcohols, and consequently the anhydrous form is an excellent dehydration catalyst. It is believed that the surface is promoted to a bisulfate stage during the phase of the catalytic process when the H and OH groups are split off of the alcohol and are combined with the catalyst. Thermogravimetric studies as a function of water vapor pressure gave approximate values of 16 Kcal/mole and 25 eu for the conversion of the bisulfate to the anhydrous stage. The free energy of the transition is zero at about 350 to 375°C. II. Colloidal silica dissolved in aqueous suspensions of high-surface-area thoria was permitted to adsorb on the thoria surface. Silica in three forms are identified by means of infrared spectroscopy, characterized by Si–O vibrational modes in the 9.0 to 10.5 micron region. A band at 9.1μ was attributed to free unadsorbed silica while adsorbed silica resulted in bands of greatest absorbance at 9.4 or 10.3μ depending upon the character of the surface bonding. Size considerations, the amount of silica adsorbed, and the character of the infrared spectrum for strongly adsorbed silica was interpreted as evidence of formation of chain or layer silica linkages on the thoria surface. III. The kinetics of silicate adsorption from aqueous colloidal ($SiO_2 \cdot nH_2O$) silicate sols on thoria (ThO_2) surfaces were determined at 100, 150, and 200°C in an autoclave system. The amount of chemisorbed silica on the thoria surface was determined by means of infrared spectroscopy. First order kinetics were observed in all cases, with the anomalous result that the first order rate constant was found to vary with the initial amount of silica added to the system. These results have been correlated quantitatively by means of a strain model of adsorption involving two types of surface silicate bonding, both of which may be readily observed in the infrared spectrum. Initial adsorption occurs rapidly to produce one type of surface silicate followed by a slow transition to a second type of surface bonding, the latter transition representing the slow step in the adsorption process. IV. Infrared spectra were obtained for hydrated thorium nitrate ($Th(ONO_2)_4 \cdot 4H_2O$) over the spectral region 4000 to 500 cm^{-1} (2.5 to 20μ) following heating to as high as 170°C. The covalent nitrato group on the hydrated thorium nitrate transformed in part to the ionic nitrate group upon removal of water by heating. The transition increased with increased degree of dehydration. These results have been interpreted in terms of the influence of the water of crystallization upon the nitrate groups by hydrogen bonding. (Dissertation Abst., Vol. 23, No. 7)

16029 METHOD AND ELECTRODE FOR PRODUCING CARBIDES OF URANIUM. (to Nuclear Materials and Equipment Corp.). British Patent 919,672. Feb. 27, 1963. Priority date Apr. 4, 1960, United States.

Uranium carbide is produced by reacting a solid body of uranium oxide and carbon in the heat of an electric arc and collecting the resulting carbide. The electric arc is formed between the solid bodies as a consumable electrode, and the reaction takes place in the plasma of the arc. (C.E.S.)

16030 IONS EXCHANGER. Pierre Cohen and René Amavis (to Commissariat à l'Énergie Atomique). Canadian Patent 655,231. Jan. 1, 1963. Priority date Nov. 16, 1959, France.

Basic lead sulfates, particularly tribasic lead sulfate, operate as true ion exchangers, fixing ions in a reversible manner even in solutions containing radioactive ions or at high temperatures. (D.C.W.)

Organic Chemistry

16031 (TID-17275) THEORETICAL STUDIES ON LIQUID COOLANTS. Status Report No. 1, January 28, 1961 to January 31, 1962. Takashi Nakamura, Sook-il Kwun, Taikyue Ree, and Henry Eyring (Utah. Univ., Salt Lake City). Contract AT(10-1)-1076. 31p.

The first of a series of theoretical studies on polyphenyls is presented. Efforts during the period were devoted to studies of polyphenyl C–C bonds. The mobile bond orders of biphenyl C–C bonds as provided by the Hueckel theory are discussed and shown diagrammatically. Examination of the pi-electron structure of the biphenyl and terphenyl molecules in the planar configuration is reported and calculations concerning the pi-electron state with the twisting angle are discussed. Other information is reported concerning properties of molecular orbitals, Hueckel theory calculations of biphenyl and terphenyls, numerical solution of Pople equations, and molecular configuration of biphenyl. (J.R.D.)

16032 (TID-18142) OPTICAL ROTATORY DISPERSION OF SOME AMINO ACIDS AND CRITERIA OF PROTEIN CONFIGURATION. Leonard I. Katzin and Elsie Gulyas (Argonne National Lab., Ill.). Dec. 1962. Contract [W-31-109-eng-38]. 11p. (UAC-7137)

Rotatory dispersion of amino acids is well represented by a two-term Drude equation. The parameters of the equation are obtained by least-squares fitting with the aid of an electronic computer, using data for some 42 different wavelengths between 0.65 and 0.27 μ. Data are presented for the amino acids alanine, serine, valine, leucine, proline, aspartic acid, glutamic acid, asparagine, and lysine, in their several states of protonation and ionization. The median root mean square deviation between experimental and computed $[\alpha]_\lambda$ is ±0.175° for the data in toto. The bearing of the data on problems of helix-random coil transition of proteins, relation of structure to optical rotation, and use of rotatory dispersion as a form of spectroscopy for attacking chemical problems was discussed. (auth)

16033 (TID-18149) POLAROGRAPHIC OXIDATION POTENTIALS OF AROMATIC COMPOUNDS. E. S. Pysh and N. C. Yang (Chicago. Univ.). [1962]. Contract AT (11-1)-1043. 30p.

The oxidation half-wave potentials of fifty-three organic compounds were determined in acetonitrile at a rotating Pt electrode. These values are correlated with ionization potentials, with interaction energies of charge-transfer complexes with trinitrofluorenone, with Hückel coefficients of the resonance integral in the expression for the highest occupied molecular orbital energy level, and with p-absorption band spectra. The correlations yield linear relations for alternate hydrocarbons. On the basis of these correlations, the values of the oxidation half-wave potentials are applied to calculate ionization potentials for aromatic hydrocarbons and to verify the values of molecular orbital calculations. (auth)

16034 (TID-18170) PROTON MAGNETIC RESONANCE STUDIES OF ACIDIC ORGANOPHOSPHORUS COMPOUNDS. John R. Ferraro and D. F. Peppard (Argonne National Lab., Ill.). Dec. 1962. Contract [W-31-109-eng-38]. 11p. (UAC-7127)

The proton magnetic resonance of 19 organophosphorus acids was studied as a function of concentration in CCl_4.

The chemical shift of the hydroxyl proton is in the direction of higher field with increasing dilution and increasing temperature. The position of this resonance at 0.5 F concentration is highest for the acids containing phenyl groups. Higher resonance values are also found for the stronger acids. Estimated hydrogen bond energies for the acidic organophosphorus compounds are found to be 5.5–6 kcals mole in CCl_4 at 1.5 F concentration. (auth)

16035 PREPARATION OF PHTHALOYLGLYCINE-1-^{14}C AND OF SOME SIMPLE GLYCYL-1-^{14}C PEPTIDES. Dénes Bánfi, István Teplán, and Lásszló Oervoes (Reanal Fine Chemical Factory, Budapest; National Atomic Energy Commission Inst. of Isotopes, Budapest; and Central Research Inst. for Chemistry, Hungarian Academy of Sciences, Budapest). Acta Chim. Acad. Sci. Hung., 35: 213-16(1963). (In English)

The preparation of some C^{14}-labeled glycyl-dipeptides is described. To achieve good radiochemical yields, a selective cleavage of the phthaloyl blocking group was evolved and applied. (auth)

16036 SYNTHESIS AND PURIFICATION OF QUINQUIPHENYL FOR SCINTILLATOR. Tadashi Nozaki (Electrical Communication Lab., Tokyo). Bull. Chem. Soc. Japan, 35: 1788-9(Nov. 1962). (In English)

A process for preparing pure quinquiphenyl is given which is based on the reaction of cyclohexanedione-1,4 with the Grignard reagent of biphenyl. The reaction is rapid when heated to 400 to 450°C in a boiling mixture of H_2SO_4 and EtOH. Purification may be effected by vacuum sublimation, recrystallization, and segregation. The properties of quinquiphenyl are described. (D.L.C.)

16037 DEUTERIUM ISOTOPE EFFECTS IN THE OXIDATION OF ALDEHYDES WITH BROMINE. P. T. McTigue and J. M. Sime (Univ. of Melbourne). J. Chem. Soc., 1303-5(Feb. 1963).

The oxidation of aliphatic aldehydes with bromine exhibited a solvent isotope effect, $k_h/k_d = 3.7$. For benzaldehyde oxidation, $k_h/k_d = 1.3$. The former involves reaction of the hydrate, the latter formation of a benzoyl cation. (auth)

16038 I. PHOTOCHEMICAL REACTION OF IODINE WITH ETHYL ETHER, ISOPENTANE, ETHYL ALCOHOL AND PROPANE. II. ELECTRON SPIN RESONANCE STUDIES OF RADICALS PRODUCED IN THE ETHYL HALIDES BY Co^{60} GAMMA IRRADIATION AT 77°K. Stephen Vincent Filseth. Thesis, Madison, Wis., Univ. of Wisconsin, 1962. 148p.

I. The mechanism of the disappearance of the iodine color from solutions of iodine in glassy EPA (ethyl ether, isopentane and ethyl alcohol in a volume ratio of 5 : 5 : 2) during irradiation with visible light at 77°K was studied. Analysis by absorption spectrophotometry shows that the bleaching is due to a photochemical reaction of iodine with the components of EPA rather than to trapped iodine atoms as had been suggested. During illumination of solutions of iodine in ethyl ether and in ethyl alcohol at room temperature, the hydrogen triiodide concentration passes through a maximum and then finally is reduced to zero when all the iodine has been converted to hydrogen iodide. In solutions of iodine in isopentane at room temperature, illumination produces hydrogen iodide without the formation of hydrogen triiodide. Using gas chromatography in conjunction with iodine-131 labeling, isopropyl and normal propyl iodides were found to be produced by the gas phase photochemical reaction of iodine with propane at 49°C. Ethyl iodide was formed in a similar reaction of iodine with ethane. The radicals produced by Co^{60} gamma irradiation of ethyl iodide, bromide and chloride at 77°K were studied by electron spin resonance. Irradiated glassy ethyl iodide showed a six-line pattern, attributed to the ethyl radical. On warming to 85°K, the spectrum slowly disappeared. An irradiated polycrystalline sample of ethyl iodide showed approximately thirty lines. This spectrum, which disappeared above 140°K, is attributed to I_2^-. A polycrystalline sample of ethyl bromide irradiated at 77°K gave an asymmetric eight-line pattern. On warming the sample to about 120°K, this pattern was replaced by a five-line signal which then disappeared at somewhat higher temperature. The signal may be due to the radical C_2H_4Br. Irradiated polycrystalline ethyl chloride showed a twelve-line symmetric pattern attributed to the ethyl radical. On warming, the distribution of relative amplitudes changed appreciably near 120°K. The entire spectrum disappeared above 140°K. (M.P.G.)

16039 POLYAMIDES FROM DIAMINES HAVING TWO DEUTERIUM ATOMS ON BOTH CHAIN CARBONS ALPHA TO THE TWO AMINO NITROGENS. Walter E. Mochel, William H. Sharkey, and Frederick T. Wall (to E. I. du Pont de Nemours and Co.). U. S. Patent 3,076,789. Feb. 5, 1963. Filed July 23, 1957.

A film- and fiber-forming polyamide, which exhibits outstanding light durability, was developed. The polyamide can be prepared from a new class of diamines by the conventional thermal polycondensation of the diamine/diacid salt. The new diamines are $\alpha,\alpha,\alpha',\alpha'$-$d_4$-diamines. They exhibit substantially the same physical properties as the diamines which do not contain deuterium and can be conveniently prepared. The preparation of the polyamides and the diamines is described in detail. (M.P.G.)

Radiation Chemistry and Radiochemistry

Refer also to abstracts 16551, 16552, 16903, and 17416.

16040 (BMI-1620) EXPERIMENTS ON ENHANCED CATALYTIC ACTIVITY FROM INTERNAL IRRADIATION OF CATALYSTS. James L. McFarling and John F. Kircher (Battelle Memorial Inst., Columbus, Ohio). Feb. 28, 1963. Contract W-7405-Eng-92. 20p.

An experimental study of the effect of internal fission-product beta radiation on a cyclohexanol dehydration catalyst was performed. The catalyst used was a $CaCl_2$-35 wt % $MgSO_4$ mixture to which was added about 5 wt % ceramic-coated UO_2 fuel particles. Conversion efficiency of this catalyst with and without the fuel particles was compared before neutron irradiation and after irradiation at three neutron dose levels. The experimental results indicated that little if any change occurred in the efficiency of the catalyst in contrast to previously reported work with a similar catalyst mixture containing Ca^{45}. (auth)

16041 (NCSC-2477-10) MODIFICATION OF TEXTILE FIBER PROPERTIES BY RADIATION-INDUCED GRAFT POLYMERIZATION. Annual Report, November 1, 1961–October 31, 1962. Arthur A. Armstrong, Jr. and William K. Walsh (North Carolina State Coll., Raleigh. School of Textiles). Oct. 31, 1962. Contract AT(40-1)-2477. 118p.

Studies of vapor-phase graft polymerization to textile fibers by means of gamma radiation were conducted in the following areas: (1) variables affecting the rate of grafting, (2) modification of fiber properties by grafting, and (3) the kinetics of vapor-phase graft polymerization. Water, methanol, and acetic acid were found to be the best sensitizers for grafting to cotton, rayon, nylon, and wool. Post-

irradiation experiments show that water is not essential during irradiation, but was necessary during the polymerization reaction. An increase in graft polymerization was obtained by the use of intermittent irradiation. Oxygen concentration above a threshold level exhibits a marked inhibition on the grafting of acrylonitrile to the various fibers. Increases in temperature generally results in decreased grafting effects. No marked changes in strength, elongation, modulus, or proportional limit resulted from grafting. The grafting of styrene gave nylon and polypropylene increased weathering resistance, but did not affect the weathering of cotton. The rate of diffusion of monomer and the kinetics of the reaction both play a significant part in the vapor-phase technique. Post-irradiation grafting experiments show that oxygen decreased the number of available radicals in acetate yarn, but had little effect on those in nylon, polypropylene, and polyester. (H.G.G.)

16042 (SRO-78) RADIATION-INDUCED CYANOGENATION OF ORGANIC COMPOUNDS. Final Report, May 1, 1960–February 28, 1963. James A. Knight, Jr. (Georgia Inst. of Tech., Atlanta. Engineering Experiment Station). Feb. 28, 1963. Contract AT(38-1)-202. 45p.

Hydrocarbons such as benzene, toluene, n-heptane, 2,2,4-trimethylpentane, 2,4,4-trimethylpentene-1, 2-methylpentane, 3-methylhexane, and cyclohexane were irradiated in a 12-kilocurie Cs^{137} source in admixture with cyanogen. Based on infrared spectra of samples of the irradiated mixtures, it was concluded that radiation-induced cyanogenation did occur under the conditions employed with each of the hydrocarbons. The radiolysis of the cyanogen-cyclohexane system was examined in more detail. Gas chromatography was used to analyze for the major radiolysis products from irradiated pure cyclohexane and mixtures of cyanogen-cyclohexane. The G values for H_2 from the mixtures were less than 4. The G values for HCN for the samples analyzed were approximately 2. The G values for cyclohexane from the mixtures varied from 1.1 for 2.44×10^{20} to 0.55 for 1.46×10^{21} ev/g and were about 50% of the G values from pure cyclohexane for corresponding doses. The G values for dicyclohexyl from the mixtures were approximately 0.4 for all doses, whereas the G values from pure cyclohexane decreased from 1.57 for 2.44×10^{20} to 0.99 for 1.46×10^{21} ev/g. The G values for cyclohexyl cyanide, obtained by analyzing different irradiated mixtures immediately after irradiation, varied from 3.9 to 10.1 for a dose of 2.44×10^{20} ev/g. Samples of these same irradiated mixtures, after treatment with KOH solution, gave G values of 14 to 18, and after treatment with KOH pellets, gave G values of 18 to 20 for cyclohexyl cyanide. The available evidence indicates that a considerable amount of the cyclohexyl cyanide in these irradiated mixtures was combined in some type of "complex" which was destroyed by treatment with base. The data are insufficient to warrant the postulation of any mechanisms for the radiolysis of the cyanogen-cyclohexane system. (auth)

16043 (TID-18094) THE EFFECTS OF RADIATION ON CHEMICAL SYSTEMS. Progress Report, Jan. 1, 1962–Dec. 31, 1962. Alexander R. Amell (New Hampshire. Univ., Durham). Dec. 31, 1962. Contract AT(30-1)-1911. 23p.

Results of research are presented on the radiation chemistry of ammonia, methylamine, dimethylamine, trimethylamine, aqueous and alcoholic solutions of methyl orange and orange IV, and acidic solutions of stannous ions. "G" values are given for products formed in these irradiations. (J.R.D.)

16044 (TID-18144) AN APPARATUS FOR THE STUDY OF PRIMARY PROCESSES IN RADIATION CHEMISTRY. J. Marquisee and E. W. Abrahamson (Case Inst. of Tech., Cleveland). [1962]. Contract AT(11-1)-904. 8p.

Efforts directed toward development of a pulsed x ray source for use in studying primary processes and intermediates in photochemical reactions are described. The field emission principle is planned for the x ray tube to obtain large pulsed currents from a heated cathode of W filaments surrounding a cylindrical target anode. Material to be studied is mounted inside the anode chamber, which is open to the atmosphere, and optical measurements are made along the axis of the anode. The elements associated with the anode and cathode were tested for thermal and electrical stability and final assembly of the tube is planned. (J.R.D.)

16045 (TID-18184) THE DECOMPOSITION OF PLUTONIUM HEXAFLUORIDE BY RADIATION. M. J. Steindler, R. P. Wagner, and J. Fischer (Argonne National Lab., Ill.). Dec. 1962. Contract W-31-109-eng-38. 4p. (UAC-7126)

The decomposition of PuF_6 resulting from γ irradiation was studied. Gaseous PuF_6, irradiated by γ radiation, decomposes to form PuF_4 and elemental F_2. The G value for the decomposition reaction in the absence of inert gases is ~7.4 mols/100 ev absorbed by both gases. Addition of Kr exerts a more pronounced effect in lowering the G value for the decomposition and its effect appears to be dependent on the pressure of the inert gas. Experiments on the decomposition of PuF_6 by its α radiation were also carried out. Results indicate that the rate of decomposition of gaseous PuF_6 at 100 mm pressure is approximately 4.7% in 12.6 days or 0.37% per day. The experimental values were compared with those calculated using the G value obtained from experiments using γ radiation. (auth)

16046 (TID-18261) RESEARCH IN NUCLEAR AND RADIOCHEMISTRY. Annual Progress Report for Year Ending January 31, 1963. T. T. Sugihara (Clark Univ., Worcester, Mass.). Contract AT(30-1)-1930. 77p.

Research in nuclear and radiochemistry involved determining isomeric ratios for several reactions to study the mechanisms and angular momentum dependence of the de-excitation modes involved in the reactions. Proton fission studies on In, Ag, and U^{238} were made to examine range energy relations for U^{238} fission products and to determine mass distributions for In and Ag. Proton fission of rare earths revealed a broad and featureless mass distribution. Techniques for separating Ca and Sr from solutions containing cations and for preparing Ra^{228} and Ra^{223} sources from solutions containing micro amounts of Ra were examined. Application of solid-state detectors to low-level alpha and beta counting situations was also considered. Separate abstracts have been prepared for ten sections of this report. (D.C.W.)

16047 (TID-18261(p.1-14)) ISOMERIC RATIOS IN $Nb^{93}(\alpha,xn)$ REACTIONS. J. M. Matuszek, Jr. (Clark Univ., Worcester, Mass.).

Excitation functions for the formation of the six product nuclides from (α,n), $(\alpha,2n)$, and $(\alpha,3n)$ reactions in Nb^{93} were obtained as well as the isomeric ratios for producing each pair of products in the reactions. The excitation functions behave as expected for a compound nuclear reaction. The excitation function for the formation of 4+ Tc^{96m} peaks about 3 Mev below that for the spin 7+ Tc^{96g} in the (α,n) reactions. Extra energy is apparently required to form the product nucleus of higher spin as theoretically

predicted. The difference in Q to ground state and metastable states is in all cases less than 40 Mev, much less than the dispersion in the beam and too small to account for the observed shift. The sum of the (α,xn) excitation functions up to 35 Mev has essentially the same shape as the total optical-model reaction cross section, suggesting that the contribution of (α,pxn) or other reactions is small. The isomeric ratio for the (α,n) reaction is similar to that obtained for (α,n) reactions in K^{41} and Mn^{55}. A rise to a maximum where the $(\alpha,2n)$ reaction becomes important is followed by a decrease, perhaps due to a direct interaction in which the angular-momentum transfer is smaller than in the compound nuclear case. The $(\alpha,2n)$ ratio shows a sharp rise at about 18 Mev, followed by a slow rise to a maximum where the $(\alpha,3n)$ reaction is at a maximum. A decrease with energy follows. The sharp rise is interpreted in terms of the spin magnitude and the energy available for kinetic energy. For certain cases Tc^{96} could conceivably decay by γ emission rather than neutron emission. The $(\alpha,3n)$ ratio revealed only an increase with energy, as expected for a compound nuclear reaction. The isomeric ratio for the (α,n) reaction was calculated by a described technique and compared with experimental values. Values for the spin cut-off parameter that gave a good fit with the experimental results are comparable to those obtained elsewhere. The variation of the parameter with excitation energy confirms earlier statements based on work with K^{41} and Mn^{55}. When the moment of inertia is held fixed, the experimental ratio increased faster than the calculated ratio. Extension of the calculations to $(\alpha,2n)$ and $(\alpha,3n)$ reactions was considered as were effects of various phenomena on the calculations. No structure in the $(\alpha,2n)$ and $(\alpha,3n)$ ratio curve similar to the 18 Mev rise in the (α,n) ratio was observed, although it was expected. Recoil ranges as a function of bombarding energy were also measured for the products of the reactions. The values obtained were compared with calculations from a theoretical relation. Generally good agreement was noted. Above 24 Mev, the recoil range levels off indicating a significant contribution of (α,n) reactions in which not all of the alpha particle momentum is transferred. The isomeric ratio also turns over at about this energy. For the $(\alpha,2n)$ case only a small deviation is noted, and that at energies >37 Mev. The corresponding isomeric ratio curve goes through a maximum at about 32 Mev. The $(\alpha,3n)$ ranges apparently behave approximately as predicted with magnitudes a bit low. The range and isomeric ratio for the $(\alpha,3n)$ reaction agree well with a compound nuclear model. 18 references. (D.C.W.)

16048 (TID-18261(p.15-18)) STUDIES OF THE $In^{115}(\alpha,2p)In^{117}$ REACTION. Norman Dudey (Clark Univ., Worcester, Mass.).

More appropriate isomeric cross section ratios and excitation functions for the production of In^{117} isomers in the $In^{115}(\alpha,2p)$ reaction at incident energies from 23–42 Mev were obtained. Details of the counting technique and of corrections for In^{116} interference are described. The excitation function suggests a compound nuclear reaction with a peak above 40 Mev incident energy. The isomeric ratio reveals an increase with energy up to 29 Mev from which it levels off to 42 Mev. The flattening out is explained by a compound nuclear model as the result of emission of heavier particles by the high-spin states of the compound nucleus. Another explanation would be for one proton to leave the residual nucleus in a high spin state; instead of the second proton, gamma rays might be emitted. Range measurements were attempted, but the low cross sections for the $(\alpha,2p)$ reaction resulted in inadequate data. (D.C.W.)

16049 (TID-18261(p.19-23)) ISOMERIC CROSS-SECTION RATIOS FOR THE $Te^{130}(p,pn)$ AND $Te^{128}(p,pn)$ REACTIONS FROM 45 TO 150 Mev. Christopher Gatrousis (Clark Univ., Worcester, Mass.).

Measurements of the isomeric cross section ratio for the $Te^{130}(p,pn)$ reaction were extended to 150 Mev, and the $Te^{127\,m}/Te^{127\,g}$ isomeric ratio for the reaction $Te^{128}(p,pn)$ was also measured. Various considerations limited the usefulness of chromatographic separation, and a modified radiochemical method was used. Beta counting was used to determine the relative yields for Te^{127} study. The relative yields of the Te^{129} isomeric pair were determined by integrating under individual photopeaks in the gamma spectrum. Measurements of the half lives of individual photopeaks in the gamma spectra revealed some divergences from the decay scheme in Nuclear Data sheets. A gamma line at 0.82 Mev that decayed with a 70-min half life was found and a 0.72-Mev gamma reported in the decay of the ground-state isomer was not observed in the spectra taken over a short time period after the irradiation. After decay of the short-lived activity, a 0.72 Mev photopeak was observed. These results and those of other workers cast doubts on earlier ideas of the Te^{129} decay scheme. The Te^{129} isomer cross section ratio also differed from earlier results obtained with beta measurements. Andersson's recent report of a β^-/IT branching ratio of $32 \pm 10\%$ for 33-day Te^{129m} makes it impossible to obtain an accurate value of the isomeric ratio based on the present status of the Te^{129} decay scheme. The isomeric ratios for Te^{127} and Te^{129} pairs were found to be constant, favoring the low spin isomer for the energy range considered. This constancy supports an energy independent mechanism for the reaction. (D.C.W.)

16050 (TID-18261(p.24-6)) ISOMERIC RATIOS IN NUCLEON-TRANSFER REACTIONS INDUCED BY HEAVY IONS. Christopher Gatrousis (Clark Univ., Worcester, Mass.).

Measurements of the Te^{127} and Te^{129} isomeric cross section ratios were extended to include their formation by neutron-transfer reactions in heavy-ion bombardment. Mechanisms by which such reactions could proceed were examined, and Te^{128} targets were irradiated with C^{12} ions 48, 62, 83, and 117 Mev. Neutron loss by the target appeared to be favored over neutron pickup. The 70-min low-spin isomer Te^{129g} is produced in very low yield in the neutron-pickup reaction that was noted to lead primarily to the high spin isomer, as was expected from angular momentum considerations. (D.C.W.)

16051 (TID-18261(p.27-43)) RECOIL STUDIES OF URANIUM FISSION FRAGMENTS. Victor E. Noshkin, Jr. (Clark Univ., Worcester, Mass.).

Recoil characteristics of certain products from the fission of U^{238} by 150-Mev protons were examined. Expressions for range-energy relations and for calculating kinetic energies from ranges were investigated. Ranges were computed in various ways as were kinetic energies for the nuclides. Preliminary analysis of the results shows that the anisotropy parameter cannot be neglected for asymmetric fragments in range calculations and that previous range results are only approximately correct for nuclides with mass 89 to 140. Comparison of the range results reveals that the ranges of asymmetric fragments do not depend on bombarding energy, indicating formation of these nuclides in reactions involving only small energy depositions. Ag^{111} was expected to form from higher deposition events than Pd^{112}. Experimentally the Ag^{111} range increased slightly with bombarding energy. Ranges were plotted against mass

number, and the results were compared with other data. No coherent pattern for the 150-Mev ranges appeared; the scatter was expected. Range differences between isobaric pairs and between certain shielded nuclides are such that the nuclide nearer beta stability has the smaller range. Four methods for computing kinetic energies from range gave results in good agreement for the mass region 91–140; below 91 the results diverged greatly. Results calculated by different methods were compared. 20 references. (D.C.W.)

16052 (TID-18261(p.44-8)) FISSION OF RARE EARTH ELEMENTS. Per Aagaard (Clark Univ., Worcester, Mass.).

Relative yields of nuclides from 150-Mev proton fission of Ho^{165} and from 80-Mev proton fission of Tb^{159} were determined. The yields for Ho^{165} are given relative to Ni^{66}, and those for Tb^{159} use Zn^{72} as the standard. Measurement and correction of the yields are discussed. Some heavier nuclides ($A \geq 111$) seemed to originate from the fission of heavy-element impurities, probably thorium. A previously reported high Mo^{99} yield in Ho^{165} was found to result from a numerical error. Absolute formation cross sections of 13 and 16 millimicrobarns were determined for Ni^{66} and Zn^{72}. (D.C.W.)

16053 (TID-18261(p.49-60)) FISSION OF LIGHT ELEMENTS. Hiroshi Baba (Clark Univ., Worcester, Mass.).

Indium fission by 40, 60, 100, and 140 Mev protons and silver fission by 140 Mev protons were examined. Chemical separation of product nuclei was done in a sequential way rather than by taking an aliquot for each element. For determination of the yields and the identification of nuclides, an end-window flow-proportional counter was used. Corrections due to decay schemes were made by reference to Nuclear Data sheets, other corrections being ignored. As a result, the relative yields were essentially unchanged, but the indium absolute cross sections were probably a few per cent low. Nuclides observed are listed and discussed, and the relative yields are given. Absolute cross sections for product nuclides of indium fission are also presented. Kofstad's cross sections for silver fission with 340 Mev protons were used for comparative purposes. Copper isotope yields appeared small in relation to Kofstad's values, perhaps due to contamination from spallation reactions of zinc in Kofstad's measurements. Remarkably large cross sections for Mn^{56} and Mn^{57} were obtained. Spallation effects and contributions from extraneous reactions may have affected some other values. An attempt was made to calculate chain yields in indium fission. The mass distribution was obtained for the 140-Mev proton fission of indium as a Gaussian with a full width at half maximum of four mass units. Swiatecki's theory of a critical value of the fissionability parameter X is consistent with the distribution observed. A similarly narrow and peaked distribution is noted for silver fission, making the abundances of Ni^{57} and Ni^{66} in indium and silver fission, respectively, understandable. An attempt was made to explain the indium and silver mass distributions in terms of Swiatecki's theory. Nuclei in the mass region considered have a calculated X value near 0.395, but higher values were noted for some nuclei. (D.C.W.)

16054 (TID-18261(p.61-70)) STUDIES OF THE Ce^{137m}/Ce^{137} ISOMERIC RATIO FORMED FROM THE COMPOUND NUCLEUS Ce^{140}. Norman Dudey (Clark Univ., Worcester, Mass.).

Additional information on the effect the distribution of angular momentum states in a compound has on its mode of de-excitation is gained by forming the nucleus in several ways. The Ce^{140} compound nucleus was formed by the reactions $Te^{128}(C^{12},3n)$ and $La^{139}(p,3n)$. Target preparation, irradiation technique, and the chemical separation process used are discussed. The Ce^{137m}/Ce^{137g} isomeric cross section ratio was measured. Detection of Ce^{137m} and Ce^{137g} was performed using both gamma-counting and x-ray counting. Results from the two techniques were deemed equivalent within experimental error. Isomeric ratios for the reactions are presented, and a marked decrease in the ratio with increasing C^{12} energy is noted. The ratio for the proton reaction rises slowly with energy with the largest value occurring at an energy where direct interactions should contribute strongly to the reaction cross section. The target spin of La^{139} ($7/2$) may be an important factor in this case. (D.C.W.)

16055 (TID-18261(p.71-2)) ANALYTICAL CHEMISTRY OF THE ALKALINE EARTHS. Francis H. Ruddy (Clark Univ., Worcester, Mass.).

An attempt was made to determine experimentally the optimum conditions for the reported precipitation of Sr from solutions containing Ba, Ca, and other cations by dilituric acid. At pH > 2 the acid precipitated better than 90% of the Sr and 70% of the Ca. The percentages decreased for lower pH, and neither element would precipitate from solutions with acidity >10M. The acid therefore cannot be used to separate Ca and Sr. Attempts were begun to use cation-exchange foils, prepared by sulfonating commercial polystyrene films, as a means for preparing Ra^{226} and Ra^{228} sources from solutions containing micro amounts of radium. (D.C.W.)

16056 (TID-18261(p.73-4)) LOW-LEVEL APPLICATIONS OF SOLID-STATE DETECTORS. Richard Ragaini (Clark Univ., Worcester, Mass.).

Feasibility of using solid-state detectors in low-level alpha and beta counting applications was examined. The necessity for small and steady background was explored by checking the background around 4.8 Mev for a gold-surface-barrier detector. Very low-level alpha counting is apparently possible with existing devices. Beta counting also appears possible, but commercial detectors with sufficient depletion depths are unavailable. (D.C.W.)

16057 (TID-18262) INVESTIGATION OF THE EFFECTS OF IONIZING RADIATION ON THE SEDIMENTATION OF SEWAGE. Quarterly Report, June 1–October 31, 1962. (Unidynamics. Div. of Universal Match Corp., St. Louis). Contract AT(11-1)-905. 43p. (UMC-B63-102)

A study of the effects of ionizing radiation on the sedimentation of colloidal clay (found in sewage and river water) and sewage were discussed. The study considered the effects of irradiation at four dose rates, 1210 rad/min, 253 rad/min, 20.1 rad/min, and 9.4 rad/min with doses ranging from 141 to 145,000 rad. The most striking modification of the colloidal clay particle size distribution occurred in the suspensions which had settled for 120 min. The total number of particles removed by sedimentation was increased 45.5% following irradiation. The particle sizes most significantly affected were those in the range of 2.5 to 3.0 μ. These observed sedimentation increases are considered to result from alteration of either the particle solvation, or surface charge, or a combination of these effects. Results of a study using sewage indicate that sedimentation increases, similar to those observed in simulated sewage, can all be affected in actual domestic sewage by ionizing radiation. The effects of radiation on sedimentation of sewage may be determined by particle count, turbidimetric, and biochemical oxygen demand methods. (H.G.G.)

16058 (AEC-tr-5687) CONTRIBUTION TO THE STUDY OF THE FORMATION AND THE DECOMPOSITION OF HYDROGEN PEROXIDE BY γ RAYS FROM Co^{60} AND α RAYS FROM Po^{210}. Anne-Marie Koulkès-Pujo. Translated by Roger G. Mansfield (Oak Ridge National Lab., Tenn.) from Ann. Chim. (Paris), 5: 707-64(1960). 88p.

A study was made to determine how the formation of H_2O_2 and radiolytic products of water in general develops under the action of γ rays and α particles. The formation of H_2O_2 by γ rays was followed as a function of pH and in the presence of air. The decomposition of solutions of H_2O_2 was studied under the same conditions. Hydrogen and oxygen formation was observed in irradiation of solutions of NaOH in the absence of air. By irradiation of solutions of NaOH with α particles in the presence of air there was apparently no radiolysis of water. It was found that sudden changes in the formation of H_2O_2 occur in the pH zones between 2 and 3, 11 and 12, and 13 and 14. The effect of chloride ions on H_2O_2 and hydrogen formation is inhibiting in the presence of air and protecting in its absence. The decomposition of solutions of hydrogen peroxide is not interfered with by the presence of Cl^- ions; but it is strongly interfered with by pH. Mechanisms to explain the effects of pH on the radiolysis of water are discussed. (M.C.G.)

16059 A CONTRIBUTION TO THE RADIOCHEMICAL POLYMERIZATION OF CETYL METHACRYLATE. J. Dobó and K. Friese (Research Inst. for the Plastic Industry, Budapest). Acta Chim. Acad. Sci. Hung., 32: 253-4(1962). (In German)

Radiochemical polymerization was investigated with a commercial preparation of cetyl methacrylate (CMA), which was formed from a mixture of methacryl esters of various higher alcohols, mainly from the cetyl ester. X irradiation was carried out at 40°C at a rate of 40000 r/hr. With traces of inhibitor, polymerization began after an induction period of 20 min and ~40% conversion was reached after 150 min. From the slope of the linear portion of the curve (20 to 150 min) a polymerization rate of 18.3%/hr (1.4×10^{-4} mole/sec) was obtained. Under similar conditions, methyl methacrylate (MMA) polymerized at a rate of 4%/hr (1.0×10^{-4} mole/sec). The rate of polymerization (V) is expressed as follows: $V = (k_p V_i^{\frac{1}{2}}/k_t^{\frac{1}{2}})(M)$, where k_p and k_t are constants of chain growth, V_i is initiation rate, and (M) is monomer concentration. Since (M) decreases during polymerization, and if V remains constant, then $k_p/k_t^{\frac{1}{2}}$ must increase. Comparison of the polymerization rates of CMA and MMA shows $V_{CMA}/V_{MMA} = 1.4$ and $(M)_{CMA}/(M)_{MMA} = 0.3$, which gives $[(k_p V_i^{\frac{1}{2}}/k_t^{\frac{1}{2}})_{CMA}]/[(k_p V_i^{\frac{1}{2}}/k_t^{\frac{1}{2}})_{MMA}] = 4.7$. (P.C.H.)

16060 THE DECAY OF IRRADIATION DEFECTS IN POLYMETHYL METHACRYLATE. I. D. Campbell and F. D. Lonney (Australian Defence Scientific Service, Victoria). Australian J. Chem., 15: 642-52(Nov. 1962).

The decay of defects in polymethyl methacrylate caused by γ irradiation was followed by electron-spin resonance. The samples were irradiated at room temperature and annealed at 80, 90, and 100°C. Two radical species can be recognized by their different modes of decay. Some attempt is made to identify the chemical groups involved and to explain the decay mechanism. (auth)

16061 THE EFFECT OF α-RADIATION ON PROTEIN MONOLAYERS. J. F. Chambers (ICIANZ Ltd., Ascot Vale, Victoria). Australian J. Chem., 16: 180-2(Feb. 1963).

An investigation was conducted on the effects of alpha sources used as electrodes for measuring the surface potentials of monomolecular films on water and on the potential itself. The alpha source was a 1-mc Po^{210} disk, and the film was comprised by bovine serum albumin. The alpha source was swept periodically over the entire film to measure the potential and in the intervals was held over the center. The results showed that the first 15 min irradiation lowered the center potential by 60 mv, and that further irradiation gave additional but smaller decreases. This effect is probably due to attack on the sulfur-containing amino acids. (D.L.C.)

16062 EFFECT OF γ RADIATION OF COBALT-60 ON DIPHENYL MERCURY. Charles Heitz and Jean-Pierre Adloff (Centre de Recherches Nucléaires, Strasbourg). Compt. rend., 256: 416-18(Jan. 7, 1963). (In French)

The effects of γ radiation from Co^{60} on diphenyl mercury in solution in benzene and in chloroform were studied. The irradiations were made in the absence of air in sealed ampules at an intensity of 25×10^{18} ev/hr/cm^3. The destruction of the diphenyl mercury was determined as a function of the dose for benzene solutions. The results show the radiosensitivity of the bond between the mercury and the C_6H_5 groups and the existence of a direct and an indirect effect of the radiation. The indirect effect is observed for solutions with concentration equal to or less than 10^{-2}M, and the direct effect is observed for solutions with high concentrations. The mechanism of the gamma-induced reactions is given. (J.S.R.)

16063 THE RADIATION STABILITY OF A NUMBER OF HETEROCYCLIC COMPOUNDS. V. A. Sharpatyi, S. A. Safarov, and K. G. Yanova (Karpov Inst. of Physical Chemistry, USSR). Dokl. Akad. Nauk SSSR, 147: 863-6 (Dec. 1, 1962). (In Russian)

The radiation stability of a compound is determined by the structure of a molecule, and by the reactivity of the molecule with the primary radiolysis products. Furan, pyrrole, thiophene, and pyridine were irradiated with fast electrons at –160 to –170°C, and the build-up of radicals was followed by the electron paramagnetic resonance method. The initial radical yields were 0.1, 0.5, and 1.1 for thiophene, pyrrole, and furan respectively. The increased reactivity of furan was due to activation of the α-position. In an analogous fashion, the radical yield from irradiating pyridine was greater than that of benzene under the same irradiation conditions. The presence of the heterogeneous nitrogen atom in the benzene ring led to an unequal distribution of electrons in the pyridine nucleus, and pyridine became more reactive than benzene. Analysis of the electron paramagnetic resonance spectra indicated that two types of radicals are formed. In one case, a H atom was removed from the heterocyclic molecule to form a radical, and in the other case, a H atom was added to a neutral molecule to give a radical. In the first case, the radical showed up as a doublet line with a splitting ~30 oersteds, and in the second case, a multiple fine structure was obtained with a total splitting of 70 oersteds. The relative intensities of the triplet were 1:2:1. Pyridine also added a hydrogen to the γ-position to give a triplet line with a splitting of about 60 oersteds between the end components, and a relative intensity of the components of 1:2:1. However, the exact position at which the H atom adds to the neutral heterocyclic molecule is not definitely known. (TTT)

16064 THE FORMATION OF DIARYLNITROGENOXIDE RADICALS ON REACTION OF AN AMINE WITH A PEROXIDE RADICAL. A. T. Koritskii and A. F. Lukovnikov (Inst. of Chemical Physics, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 147: 1126-9(Dec. 11, 1962). (In Russian)

The evidence of electron paramagnetic resonance (EPR) measurements on samples irradiated at low temperatures indicated that a secondary aryl amine can react with peroxy radicals as follows: $ROO^{\bullet} + HNAr_2 \rightarrow ROOH + {}^{\bullet}NAr_2$ and $ROO^{\bullet} + {}^{\bullet}NAr_2 \rightarrow RO^{\bullet} + ON^{\bullet}Ar_2$. The $(C_6H_5)_2\,N^{\bullet}O$ radicals react readily with $R^{\bullet}$ and $ROO^{\bullet}$ radicals by the following mechanisms: $R^{\bullet} + (C_6H_5)_2\,N^{\bullet}O \rightarrow RON(C_6H_5)_2$, and $ROO^{\bullet} + ON^{\bullet}(C_6H_5)_2 \rightarrow RON(C_6H_5)_2 + O_2$. Samples of cumene containing a peroxy impurity and a secondary amine were irradiated with 1.6-Mev electrons at varying concentrations of the peroxy compound and of the secondary amine. On irradiating at temperatures greater than 0°C, the concentration of $Ar_2N^{\bullet}O$ rose to a peak, and then fell off sharply. It was noted that the concentration of $Ar_2N^{\bullet}O$ radicals continued to rise for a rather long time after the irradiation. If the irradiation was repeated, there was a sharp drop in concentration of $(Ar)_2N^{\bullet}O$ radicals. It was considered possible that Ar_2NH is formed as an intermediate compound, and that this compound is oxidized to $Ar_2N^{\bullet}O$ radicals at high concentrations of peroxy radicals. (TTT)

16065 FORMATION OF $Zr^{97}Cl_4$ BY THE SLOWING-DOWN OF THE FISSION FRAGMENTS IN GAS MIXTURES CONTAINING CHLORINE. I. Zvara, L. K. Tarasov, M. Krzhivanek, Khun-Kuei Su, and T. S. Zvarova (Joint Inst. of Nuclear Investigations, USSR). Dokl. Akad. Nauk SSSR, 148: 555-7(Jan. 21, 1963). (In Russian)

Use of gaseous compounds for increasing the rate of radiochemical decomposition is especially effective when the compounds may be prepared by slowing down the recoil atoms in the gas phase and removing them afterwards from the gas stream. For this reason, the conditions of the formation of Zr^{97} from fission fragments, in the gas phase in the form of $ZrCl_4$, were investigated. The experiments were carried out with a target consisting of a U_3O_8 layer on a mica support in fluorothene plastic, irradiated by neutrons from a Po–Be source; the plastic allowed a large portion of the fission fragments to pass. Analysis of the gas stream indicated that at temperatures >170°C the Zr^{97} is obtained in the form of its tetrachloride; $Zr^{97}Cl_4$ was obtained even when the gas mixture contained considerable amounts of O. The yield was about 75%. The compound was formed from both primary Zr^{97} fragments and from Zr^{97} originating from the β-decay of Y^{97}. The condensate was slightly contaminated with an as yet undetermined nuclide with a $T_{\frac{1}{2}} = 20$ min. The purification coefficient with respect to other fission fragments was found to be about 300. (TTT)

16066 THE EFFECT OF RADIOACTIVE EMISSION FROM $Na_2\overset{*}{W}O_4$ AND $Na_2\overset{*}{S}O_4$ ON THE PHASE TRANSFORMATIONS OF THESE COMPOUNDS. I. E. Mikhailenko and Vikt. I. Spitsyn (Inst. of Physics and Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 148: 613-16 (Jan. 21, 1963). (In Russian)

In order to determine the effect of radiation on the transformation of chemical compounds, the changes caused by the irradiation of Na_2WO_4 and Na_2SO_4 with slow neutrons and γ radiation on their phase transformation were investigated. The salts were chosen because their phase transformations are well studied. Exposure to a slow neutron flux of 8×10^{12} n/cm^2 sec and a γ radiation of 4×10^7 r/hour resulted in the formation of radioactive isotopes; in view of short lives, only the following were taken into account: in Na_2WO_4–W^{188} with an $E(\beta)$ max = 0.4 Mev; $T_{\frac{1}{2}} = 73.2$ days and in Na_2SO_4–S^{35} with an $E(\beta) = 0.167$ Mev $T_{\frac{1}{2}} = 87.1$ days. The exposed and unexposed materials were subjected to identical thermal analysis. It was found that the melting point and the temperature of the phase transformation of the irradiated $Na_2\overset{*}{W}O_4$ sample were not affected, indicating that the exposure did not induce residual changes in the crystal lattice, or that the defects formed were subsequently annealed out. Exposure to γ radiation had a stronger effect. The melting point was lowered in both cases; as the radioisotopes decayed, the melting points rose. The amount of the lowering of the melting point depends not only on the specific activity but also on the heat treatment. The radioactive wolframate presented a more complex electron paramagnetic resonance spectrum than the unirradiated material. (TTT)

16067 ELECTRON PARAMAGNETIC RESONANCE SPECTRA OF γ IRRADIATED MULTIBOND COMPOUNDS. V. I. Smirnova, D. N. Shigorin, and T. S. Zhuravleva. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 78-80(Jan. 1963). (In Russian)

Electron paramagnetic resonance spectra of γ-irradiated acetylene and hetero-atomic compounds were studied at 77°K in order to determine the relation between the structure of initial molecules and the developed radicals. (R.V.J.)

16068 ORGANOSILICON COMPOUNDS. PART XXIII. THE γ-RADIATION-CATALYSED ADDITION OF SOME ORGANOSILICON HYDRIDES TO SOME ORGANOVINYLSILANES. C. Eaborn and H. Niederpruem (Leicester Univ., Eng.). J. Chem. Soc., 797-9(Feb. 1963).

The reaction between organosilicon hydrides and vinyl silicon compounds under irradiation from a 100-C Co^{60} source was investigated. Some of the organosilicon hydrides were found to add to some of the organovinylsilanes. Triphenylvinylsilane alone was unchanged after irradiation for 64 hr. (P.C.H.)

16069 RADIATION DAMAGE IN ORIENTED POLYAMIDES. Michio Kashiwagi (Toyo Rayon Co., Otsu, Japan). J. Polymer Sci. Pt. A, 1: 189-202(Jan. 1963).

Oriented polyamides were irradiated with 1.5-Mev electrons, and the paramagnetic resonance was examined to determine the radical species. The spectrum is composed of two radical species, which decay at different rates. The predominant radical has a spectrum with three main lines (intensity ratio; 1 : 2 : 1), each split into two. The doublet splitting changes with the rotation of the magnetic field, whereas the triplet splittings undergo slight change. The spectrum indicates that the radical is of an unpaired electron interacting with one σ-proton and two equal π-protons. In addition, the width of the individual lines is broad (half width = ca 18 gauss) and it is presumably due to the ill-resolved hyperfine structure of the NH group. These confirm that the radical is $-CONH\dot{C}HCH_2-$. The other radical has a five-line spectrum, which indicates that the radical may be of the type resulting from a $-C-\dot{C}-$ bond scission. (auth)

16070 RADIOLYSIS OF THE ISOMERIC POLY(BUTYL METHACRYLATES). Israel S. Ungar, John F. Kircher, William B. Gager, Francis A. Sliemers, and Robert I. Leininger (Battelle Memorial Inst., Columbus, Ohio). J. Polymer Sci. Pt. A, 1: 277-88(Jan. 1963).

A study was made of the effect of gamma radiation on the production of free radicals in poly(butyl methacrylates). A mechanism of radiation attack on the polymers is proposed. Free-radical measurements and the determination of the products of irradiation were used in establishing the mechanism. The effects of configuration of the ester chain on radiation susceptibility are discussed. (auth)

16071 DEHYDROPEPTIDE PRODUCTION IN THE RADIOLYSIS OF SOLID PEPTIDES: A RADIOLYTIC SYNTHESIS OF PYRAZINE DERIVATIVES FROM CYCLIC

DIPEPTIDES. Mathilde Kland-English and Warren M. Garrison (Univ. of California, Berkeley). Nature, 197: 895-7(Mar. 2, 1963). (UCRL-10186)

Reaction mechanisms involved in the radiolysis of compounds containing the peptide bond are discussed. Data are presented on the formation of pyrazine derivatives through γ radiolysis of the amino acid anhydrides followed by dissolution of the irradiated solids in alkaline solution. (C.H.)

16072 SYNTHESIS OF ORGANIC COMPOUNDS BY HIGH-ENERGY ELECTRONS. J. Oró (Univ. of California, Berkeley and Univ. of Houston, Tex.). Nature, 197: 971-4(Mar. 9, 1963).

Experiments using C^{14}-methane and 5-Mev electrons showed that organic compounds are formed during the irradiation of mixtures of methane, ammonia, and water when these reactants are in the gas phase and also when they are in the solid phase. Radioautographic patterns of the compounds formed by high-energy electrons were similar to those obtained by electric discharges. The compounds detected by comparing two-dimensional chromatograms include amino acids, amino acid amides, amines, and other molecules of biological significance. The positions of some radioactive spots on the chromatograms corresponded closely to those of some purines and pyrimidines. It is suggested that radiation synthesis of organic and biochemical compounds is an important cosmic process. (C.H.)

16073 URANIUM(VI)–CHROMOTROPIC ACID CHELATE. Samir K. Banerji and Arun K. Dey (Univ. of Allahabad, India). Nature, 197: 1002-3(Mar. 9, 1963).

Disodium-1:8-dihydroxy naphthalene-3:6-disulfonate (chromotropic acid, sodium salt) yields colored lakes with various cations. Data are presented on the composition and stability of the uranyl ion-chromotropic acid chelate as determined by spectrophotometric examination. (C.H.)

16074 CONSTRUCTION AND EXPLOITATION OF LOOP FOR IRRADIATION OF ORGANIC FLUIDS. J.-L. Meylan (EPF, Würenlingen, Switzerland). Neue Tech., 4: 630-5(Dec. 1962). (In French)

The principles needed for the design of an organic in-pile loop are reviewed. Some aspects of the operating experience with diphenyl at 300°C (irradiation in the swimming-pool reactor SAPHIR) are presented. The description and the characteristics of the installation are given. (auth)

16075 SOME COMPLEX COMPOUNDS OF NEPTUNIUM(IV) AND RELATED IONS. Tomitaro Ishimori and Eiko Nakamura (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 1: No. 1, 6-11(Sept. 1962). (In German)

The phenylarsonate, oxalate, mandelate, and ethylenediaminetetraacetate of neptunium(IV) were radiochemically surveyed by the solvent extraction technique. An equation given by Schubert as well as another one evolved by Ishimori for the composition of complex compounds, were applied to the measured distribution ratios in a di-(2-ethylhexyl)-phosphoric acid-hydrochloric acid system containing a complexing agent. The determined molar ratios of the complexing agents: neptunium(IV) were 2, 4, and 1 for phenylarsonate, oxalate, and ethylenediaminetetraacetate, respectively. No mandelate of neptunium(IV) was observed in the acidity range studied. The dissociation constants for most of the complex compounds were calculated. (auth)

16076 MECHANISMS FOR THE REACTIONS FOLLOWING RADIATIVE NEUTRON CAPTURE IN LIQUID ORGANIC HALIDES. Miriam Milman (Ecole Normale Superieure, Orsay, France). Radiochim. Acta, 1: No. 1, 15-20(Sept. 1962). (In English)

The available data together with some recent experiments were reconsidered with regard to establishing a unified approach to the chemistry of hot atoms. It was found that the "Impact Model," originally proposed for the hot reactions of tritium atoms in gases, can also give an adequate picture for the reactions of activated halogen atoms in liquid organic halides. (auth)

16077 RADIOCHEMICAL CHANGES IN POLYMERS. I. DESTRUCTION OF PHOSPHORS IN POLYSTYRENE BY THE ACTION OF REACTOR RADIATION. H. Heusinger and E. Weber (Technische Hochschule, Munich). Radiochim. Acta, 1: No. 1, 35-42(Sept. 1962). (In German)

The aim of these investigations is a better understanding of the chemical changes caused by radiation in polymers and of the interaction between the molecules of polymer and additives which accompany these changes. The destruction by ionizing radiation of phosphors in polystyrene is described. (auth)

16078 PHASE INDEPENDENCE OF MAJOR REACTION MECHANISMS OF RECOIL CARBON ATOMS. Colin MacKay and Richard Wolfgang (Yale Univ., New Haven and Haverford Coll., Penna.). Radiochim. Acta, 1: No. 1, 42-7 (Sept. 1962). (In German)

The reactions of recoil carbon with ethylene, ethylene oxide, and isobutane were compared in the gaseous and condensed states. Remarkably little phase dependence of the products of these reactions was found. The results show that there is little if any contribution from mechanisms involving reactions of the carbon atom with radical debris produced in its recoil track. Instead the reactions by which recoil carbon enters combination seem quite analogous to those of similar reactive species (such as CH_2) produced by more conventional means. The detailed reaction mechanisms previously proposed for reactions of atomic carbon with gaseous hydrocarbons, C–H and C=C bond insertions, also appear dominant in the condensed phases. The small changes with phase that are observed are consistent with the expected action of a solvent cage in promoting the de-excitation or secondary reaction of unstable intermediates produced by the insertion reactions. (auth)

16079 COPRECIPITATION OF ACTINIDES WITH THE PEROXIDES OF OTHER ACTINIDES. G. A. Dupetit and A. H. W. Aten, Jr. (Institut voor Kernphysisch Onderzock, Amsterdam). Radiochim. Acta, 1: No. 1, 48(Sept. 1962). (In German)

Studies were made of the coprecipitation of tracer quantities of actinides with actinide peroxides. (M.C.G.)

16080 RADIATION-INDUCED CHAIN OXIDATION IN AQUEOUS $Sb^{III}-Fe^{II}$ SOLUTION. [PART] I. Niro Matsuura, Yoshimi Kurimura, and Masao Takizawa. Rika Gaku Kenkyusho Hokoku, 38: 328-33(1962). (In Japanese)

16081 ON THE FLOW TEMPERATURE AND THE DEGREE OF CRYSTALLINITY OF GRAFT COPOLYMERS PRODUCED BY HIGH-ENERGY RADIATION. Toshiaki Takamatsu and Kenichi Shinohara. Rika Gaku Kenkyusho Hokoku, 38: 409-14(1962). (In Japanese)

16082 IRRADIATION OF POLYVINYL CHLORIDE IN METHANOL. Toshiaki Takamatsu, Kenichi Shinohara, and Sanae Yoshida. Rika Gaku Kenkyusho Hokoku, 38: 415-18 (1962). (In Japanese)

16083 R. I. LABELED ORGANIC COMPOUNDS UNDER IRRADIATION. [PART] III. Ko Taki. Rika Gaku Kenkyusho Hokoku, 38: 419-33(1962). (In Japanese)

16084 THE EFFECT OF γ IRRADIATION ON THE CATALYTIC ACTIVITY OF NICKEL. Irena Opalińska

and Stanisław Cibrowski (Inst. of General Chemistry, Warsaw). Roczniki Chem., 36: 1369-72(1962). (In English)

The effect of irradiation on the ability of Ni to catalyze the hydrogenation of propylene was investigated. The Ni catalyst was prepared by oxidation in air at 900°C for 2 hr, then reduced in hydrogen at 400°. It was irradiated at a dose rate of 400000 r/hr during the course of the reaction. After irradiation was begun, a 3-fold increase in the reaction rate was noted. The effect was attributed to an induction of crystal defects, which increase the catalytic efficiency. This is possible since the maximum energy transferred from secondary 1.25-Mev photo or Compton electrons to Ni atoms is 102 ev, which is sufficient to produce vacancies or interstitials (requiring ~25 ev per defect). However, the probability of such changes is very low and only a small number of defects would be expected. (H.H.D.)

16085 THE SYNTHETIC ELEMENTS. [PART] III. Glenn T. Seaborg and Arnold R. Fritsch. Sci. Am., 208: 68-78(Apr. 1963).

Discussion is given on the discovery of elements 102 and 103 and the effort to produce elements of still higher atomic number. (P.C.H.)

16086 MEAN ENERGY EXPENDITURE W FOR FORMATION OF ION PAIRS IN GASES BY ELECTRONS, BETA, GAMMA, AND X RADIATION. Jochen Booz and Heinrich Georg Ebert (Universität, Göttingen, Ger.). Strahlentherapie, 120: 7-33(Jan. 1963). (In German)

Values for the mean energy necessary for formation of an ion pair in air, He, Ne, Ar, Kr, Xe, H_2, N_2, O_2, CO_2, H_2O-vapor, CH_4, C_2H_2, C_2H_4, C_2H_6, C_3H_6, and C_3H_8 and the methods for their determination are discussed. The mean energy per ion pair for air is constant for beta, gamma, and x rays between 20 kev and 3 Mev; its value is $W_{air} = (33.8 \pm 0.2)$ ev. In all the other energy ranges the results do not agree. Beyond 20 kev the value is $W_{air} = (33.8 \pm 0.5)$ ev too using relative measurements. These values, however, are based on the assumption, that $W_{argon} = 26.35$ ev is energy independent. Absolute measurements result in $W_{air} = (35.0 \pm 0.5)$ ev. Also above 3 Mev there are significant differences in the results of the two different methods. There is no energy dependency of W_{air} when the total specific ionization is determined. However, W_{air} decreases to 33 ev when thimble chambers are used. The mean energy per ion pair for noble gases and hydrogen has probably the same value for electrons and alpha particles with energies above 20 kev. The influence of gas impurities on the results obtained with helium, neon, and argon is remarkable. (auth)

16087 DOSE DEPENDENT CHANGES TO THE AMYLOSE MOLECULES OF A 2.5% STARCH SOLUTION AFTER Co^{60}-IRRADIATION. Karlheinz Renner, Juergen Seifert, and Klaus Peter Gerhards. Strahlentherapie, 120: 81-6(Jan. 1963). (In German)

Changes occurring in 2.5% starch solution after Co^{60}-irradiation are reported. The splitting of the amylose molecule was determined with Lugol's solution during a series of alcohol precipitation, and by changes in viscosity. The breakdown of the amylose molecule increased with increasing dose; the amylose molecule was completely gone after irradiation with 1,000,000 rad. The size of the formed part-molecules is statistically random. Accumulation of glucose in the solution could not be determined. (auth)

16088 ON SENSITIZED LUMINESCENCE OF $Ca_3(PO_4)_2$–Ga, Mn AND $Ca_3(PO_4)_2$–In, Mn. I. Muuga and N. Lushchik. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 18, 51-6 (1962). (In Russian)

The phosphors $Ca_3(PO_4)_2$-Ga, Mn and $Ca_3(PO_4)_2$-In, Mn were synthesized and their spectral characteristics were studied. The existence of sensitized migration of energy from the excited In^+ and Ga^+ ions to the Mn^{2+} ions in these phosphors was established. (auth)

16089 ON PHOSPHORESCENCE OF BORONPHTHALIC PHOSPHORS. G. M. Kislyak and G. M. Lisenko (Poltava Pedagogical Inst., Ukrainian SSR). Ukr. Fiz. Zh., 7: 1309-13(Dec. 1962). (In Ukrainian)

The phosphorescence of boronphthalic phosphors in the temperature region +160 to −183°C was studied. On the basis of the results, curves are constructed for the dependence of the duration (τ) and intensity of phosphorescence on the temperature. Throughout the temperature range concentrational extinction of τ of phosphorescence is noted. The energies of activation of the metastable state and of the extinction of the phosphorescence intensity are determined. It is shown that the law of phosphorescence extinction is exponential. (auth)

16090 EFFECT OF THE TEMPERATURE ON THE PHOSPHORESCENCE OF PHTHALIC ACID IN ALUMS. G. M. Kislyak and G. M. Lisenko (Poltava Pedagogical Inst., Ukrainian SSR). Ukr. Fiz. Zh., 7: 1314-17(Dec. 1962). (In Ukrainian)

The phosphorescence of phthalic acid in alums was studied over a temperature range of +125° to −183°C. Curves were constructed for the dependence of the intensity of τ of phosphorescence on the temperature. The energy of activation of the metastable state was determined. The afterluminescence of phthalic acid in alums is well described by the scheme of A. Yablonsky with three levels. (auth)

16091 NEW PROBLEMS IN RADIOCHEMISTRY. V. I. Spitsyn. Vestn. Akad. Nauk SSSR, 33: No. 1, 11-15(Jan. 1963). (In Russian)

A short survey is given on radiochemistry and the utilization of radioactive materials as catalysts, sorbents, and evaporation activators. (R.V.J.)

16092 THE INFLUENCE OF CONTACTS ON THE α-PARTICLE-INDUCED CURRENT IMPULSES IN CADMIUM SULFIDE CRYSTALS. Oskar Dehoust (Technische Hochschule, Munich). Z. Physik, 172: 19-48(1963). (In German)

The effect of the electrode contact on pulses induced by α particles in single crystals of CdS grown by the Frerichs method was investigated to ascertain whether such crystals are suitable as particle counters. Thin, transparent metal electrodes were prepared on both sides of the crystals at room temperature, or above, by vacuum evaporation after surface cleaning by glow discharge. Crystals with ohmic contacts (In, Ce) showed space charge limited pulse currents; the rise time of these pulses was longer than the dielectric relaxation time. When a thin sheet of an insulating material was interposed between crystal and electrode, polarization caused pulse amplitude to decrease very rapidly. It follows from the results that the polarizing charge is located at the electrodes. Saturation pulses were obtained with Cr, Mn, and Au electrodes deposited on crystals at higher temperatures. Measured photovoltaic effects confirmed the existence of a surface-barrier potential at the electrodes. An energy resolution of about 20% for α particles of 4.8 Mev was obtained for a crystal with Au electrodes. In regard to the charge carried by holes, the amount of energy required to produce an electron-hole pair was determined to 7.25 ± 1.2 ev. The mobility range of the holes was estimated to be $2 \lesssim \mu \lesssim 8$ cm²/Vsec. These results show that a CdS crystal can only be used as an α-particle detector with good time and energy resolution if

there is a potential barrier immediately under the electrode. (auth)

16093 THE FORMATION AND RECOMBINATION OF RADICALS IN THE γ-IRRADIATION OF SOLID AMMONIA AND HYDRAZINE. V. I. Tupikov, V. I. Tsivenko, S. Ya Pshezhetskii, A. G. Kotov, and V. K. Milinchuk. Zh. Fiz. Khim., 37: 138-42(Jan. 1963). (In Russian)

The formation of radicals and hydrazine in the γ-irradiation of solid ammonia at −195° was investigated. Correlation between the concentrations of these substances leads to the conclusion that the basic process leads to the hydrazine formation in recombination of NH_2 radicals. Investigations were also carried out on the formation of radicals in the γ-irradiation of frozen hydrazine. The steady state radical concentration is about 10^{29} radicals/g N_2H_4 and exceeds by about an order of magnitude the concentration of radicals formed under the same conditions in solid ammonia. The EPR spectrum of irradiated hydrazine is a singlet. Available data showed that mainly N_2H and N_2H_3 radicals are formed. The relation between radical formation and the radiation dose corresponds to bimolecular radical recombination kinetics. (auth)

16094 RADIATION EFFECTS ON ORGANIC MATERIALS. Robert O. Bolt and James G. Carroll, eds. New York, Academic Press, 1963. 585p. (TID-18092)

Nuclear radiation and its effects on the properties of organic liquids, solids, and gases are discussed. Chapters include: interaction of radiation with matter, mechanisms of chemical effects of ionizing radiation, radiation chemistry of pure compounds, polymers, plastics, elastomeric materials, coolants, lubricants, adhesives, textiles, coatings and films, dielectric fluids, fuels and fluid shield materials, coal and wood, explosives, and potential benefits. Separate abstracts were prepared for each topic. (M.C.G.)

16095 INTERACTION OF RADIATION WITH MATTER. Amos S. Newton. p.7-34 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The processes by which radiation loses energy and their significance in radiation-effects work are reviewed. The reactions of swiftly moving charged particles, neutrons, and electromagnetic radiations with matter are described. Physical aspects of the interactions, sources of radiation, and dosimetry are discussed. (M.C.G.)

16096 MECHANISMS OF CHEMICAL EFFECTS OF IONIZING RADIATION. Amos S. Newton. p.35-62 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The chemical aspects of the absorption of ionizing radiation in matter are considered. The nature of ionizing-radiation tracks, time scale of events, primary processes in radiation chemistry, excited states of molecules, and secondary processes in radiation chemistry are discussed. The effects of the physical state of matter on radiation reactions with it are described. The effects of linear energy transfer in the radiolysis of materials in water solution and in organic systems are discussed. The chemical results of irradiation described include: gas production from organic compounds, polymer formation, polymerization of unsaturated compounds, cross linking and degradation, and consecutive processes. Protection and sensitization are also discussed. (M.C.G.)

16097 RADIATION CHEMISTRY OF PURE COMPOUNDS. K. Lynn Hall, Robert O. Bolt, and James G. Carroll. p.63-125 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The radiation chemistry of saturated and unsaturated aliphatic hydrocarbons, aromatic hydrocarbons, oxygen-containing compounds, and organic halides is discussed. The emphasis is on observed products and their relation to the mechanism of radiolysis rather than on primary processes. Mechanisms, effects of structure, effects of experimental variables, effects of additives, polymerization by chain reaction, and irradiation of mixtures are discussed. (M.C.G.)

16098 POLYMERS. Oscar Sisman, William W. Parkinson, and C. Daniel Bopp. p.127-81 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The molecular and chemical structures of polymers and the characteristic properties that they confer on polymeric materials are described. Polymers can be separated into two major chemical types: addition and condensation. The effects of chemical structure, crystallinity, mobility of polymer molecule, temperature, and plasticizers on mechanical properties are described. Radiation effects on polymers, including cross linking, scission, changes in optical and electric properties, and evolution of gases, are discussed. It is shown that the controlling factor in the behavior of polymeric materials under irradiation is the chemical structure. (M.C.G.)

16099 PLASTICS. C. Daniel Bopp, William W. Parkinson, and Oscar Sisman. p.183-244 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The changes that occur in commercial plastics as a result of exposure to high-energy radiation are discussed. Quantitative values are given insofar as possible for changes in properties useful in engineering design. Topics covered include: effects of radiation on mechanical properties, radiation effects on electrical and optical properties, use of plastics in radiation fields, improvement of properties by irradiation, and radiation protection. The materials are grouped according to similarities of chemical composition or molecular structure in the following categories: hydrocarbon polymers, nitrogen-containing polymers, oxygen-containing polymers, halogen-containing polymers, and thermosetting resins. Data are presented in tabular form. (M.C.G.)

16100 ELASTOMERIC MATERIALS. John W. Born. p.245-88 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

Rubber technology is described along with general radiation effects on elastomeric materials. Specific examples are presented. Beneficial applications of radiation are treated. Radioinduced deterioration in service performance and thresholds of radiation damage to rubber products are discussed. (M.C.G.)

16101 COOLANTS. James G. Carroll, Robert O. Bolt, and Charles A. Trilling. p.289-348 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The effects of radiation on organic coolants, specifically, highly aromatic hydrocarbons, are discussed. The thermal stability of organic coolants, radiation effects as observed in static irradiations, results of in-pile loop studies, and operation of the Organic Moderated Reactor Experiment are reviewed. The nature of products from the radiolysis of polyphenyl mixtures is described. (M.C.G.)

16102 LUBRICANTS. James G. Carroll and Robert O. Bolt. p.349-406 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The radiation stability of the finished lubricant was found to be determined predominantly by the chemical nature of the base oil. In general, any substituents on the aromatic nucleus reduce radiation stability. Those base oils studied were petroleum oils, esters, alkylaromatics, silicones, halogenated compounds, ethers, and solid films. The addi-

tives considered include: radiation-damage inhibitors, antioxidants, viscosity-index improvers, gelling agents, antiwear additives, extreme-pressure agents, foam inhibitors, and rust inhibitors. The effects of temperature and oxygen are discussed. Studies were made of commercial oils, oils of enhanced radiation stability, lubricating greases, and hydraulic fluids. (M.C.G.)

16103 ADHESIVES. Robert Y. Mixer. p.407-24 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

Radiation-effects data for adhesives are correlated with those for model compounds and for analogous organic materials. Aspects discussed include the effect of temperature, type of radiation, fillers, and protectors. Some possible damage mechanisms are also presented. Adhesives, on irradiation, behave quite like the corresponding plastics or reinforced plastics. It was found that adhesives and reinforced plastics that have high thermal stability generally show high radiation resistance. The inorganic filler in the adhesive was found to offer substantial radiation protection. (M.C.G.)

16104 TEXTILES. Henry A. Rutherford. p.425-45 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The effects of radiation on cotton, rayon, acetate, wool, nylon, Dacron, and Orlon are described. Structure of fibers and similarity of fiber and base polymer behavior are discussed. Radiation effects on tensile strength and other physical properties, radioinduced oxidation, relative rates of degradation as determined by physical-property changes, mechanism of degradation, and cross linking as influenced by draw ratio are discussed. It is shown that cotton, rayon, acetate, and wool are predominantly degraded no matter what criterion is used to establish the effect. Nylon, Orlon, and Dacron are more resistant to radiation and at low dose levels may show an increase in modulus, indicating cross linking, without significant changes in other properties. (M.C.G.)

16105 COATINGS AND FILMS. James G. Carroll and Robert O. Bolt. p.447-69 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

Studies of radiation effects on coatings and films reviewed were concerned mainly with protective coatings and include discussions on coatings, packaging film, asphalts, and waxes. Radiation effects discussed include: blistering, cracking, peeling, increased porosity, discoloration, and strength changes. The effects of plasticizers, pigments, and the type of material coated are described. It is shown that the best types of coatings for up to 10^9 rad are the phenolics, silicone alkyd enamels, and alkyds and epoxy formulations. Coatings containing aromatic compounds were found to be, in general, more resistant to radiation than those containing nonaromatics. (M.C.G.)

16106 DIELECTRIC FLUIDS. Raymond S. Alger. p.461-83 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

Liquid dielectric materials include the vegetable oils, mineral oils, halogenated hydrocarbons, and silicones. A graph is presented comparing several common dielectrics on the basis of tolerance to γ or electron radiation. The structure and dielectric behavior of simple molecules are discussed. The discussion is extended to available insulating oils and their engineering applications. The radiation effects on liquid dielectrics were considered under three categories: transient effects, gas evolution, and solid and liquid reaction products. Points considered in determining the extent of radiation damage include: influence of type and rate of radiation, ionization products, energy considerations, and G values. (M.C.G.)

16107 FUELS AND FLUID SHIELD MATERIALS. James G. Carroll and Robert O. Bolt. p.485-507 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The effects of radiation on jet fuels and fluid shield materials are reviewed. The neutron-shielding ability of hydrogenous fluids does not change appreciably with irradiation up to the order of 50×10^8 rads. The most important effect of radiation on jet fuels is a degrading of thermal stability as measured by filter-plugging tendency at high temperatures. Between 10^5 and 10^7 rads, thermal stability is impaired for most fuels. At 10^8 rads some fuels show no change, while others are degraded. Above 5×10^8 rads, thermal stability appears to be improved. Studies indicated that neutrons are more damaging to jet fuel thermal stability than gamma rays. Physical and chemical properties of jet fuels are not materially changed by doses below about 10^7 rads. (M.C.G.)

16108 COAL, WOOD, AND EXPLOSIVES. Irving A. Breger, James G. Carroll, and Robert O. Bolt. p.509-37 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The known effects of nuclear radiation on coal as they may apply in problems of coal combustion are reviewed along with suggestions regarding other applications of irradiated coal. Dehydrogenation and decarboxylation are the major radiochemical reactions in irradiation of coal. It was concluded that coal is extremely resistant to degradation by radiation. Physical and chemical effects of radiation on wood are described. The radioinduced depolymerization of cellulose to make it water soluble in converting sawdust to cattle feed is discussed. Radiation effects on explosives are also described. The lower limit at which decomposition could be detected was about 10^6 rads. Large gas evolution was not entirely related to a decrease in explosiveness. The following materials are arranged in order relative to radioinduced decomposition: lead styphnate, TNT, tetryl, and lead azide. (M.C.G.)

16109 POTENTIAL BENEFITS. James G. Carroll and Robert O. Bolt. p.539-52 of "Radiation Effects on Organic Materials." New York, Academic Press, 1963.

The use of radiation to produce a useful or upgraded product is discussed. Radiation sources and types of reactions are described. Beneficial effects on hydrocarbons, plastics, elastomers, graft copolymers, and chemicals are discussed. (M.C.G.)

16110 THE EFFECT OF REACTOR RADIATION ON POLYPROPYLENE. Samuel Estelle Chappell. Thesis, University Park, Penna., Pennsylvania State Univ., 1962. 71p.

An investigation of the change in physical properties of high density, isotactic polypropylene subsequent to irradiation in nuclear reactors was carried out. Polypropylene was found to undergo both crystalline destruction and crosslinking. When the extent of crosslinking, as determined by solvent extraction studies, is compared with that of high density polyethylene, a considerably higher radiation dose is required in the case of polypropylene to produce the same gel content. Samples having initially two different crystallinities were examined by infrared absorption and solvent extraction techniques. At low radiation doses, a significant difference in the gel content and in the concentration of oxidation products as well as of c-c double bonds is observed in the samples, the samples of higher crystallinity having less gel content but containing more

oxidation products and c-c double bonds. These results are interpreted to arise from a higher concentration of trapped free radicals in the higher density samples, the radicals being trapped mainly in crystalline regions and existing for long periods after irradiation. At higher doses, when the state of order of the samples is greatly reduced, the radiation effects appear to be almost identical in both samples. When the samples are exposed at two different intensity levels of radiation, the gel content is found to be the same in both cases. The decrease in crystallinity for a given dose, as determined by infrared absorption, appears to be slightly greater at the higher dose rate. (M.P.G.)

16111 NUCLEAR MAGNETIC RESONANCE STUDIES OF NEUTRON-IRRADIATED FLUORIDES, ESPECIALLY LITHIUM FLUORIDE. Charles Dwaine Knutson. Thesis, Providence, Brown Univ., 1962. 178p.

The decomposition of LiF produced by neutron irradiation in reactors was studied by nuclear magnetic resonance (NMR) techniques. Several sets of crystals and powdered samples were irradiated at a variety of temperatures from 25 to 150°C, for total neutron doses between 10^{15} and 2×10^{19} nvt. After irradiation, distinctive lines were found superimposed upon the characteristic NMR spectrum of LiF. By a detailed study of their properties, the additional lines were shown to be due to F^{19} nuclei in a gaseous F phase and to Li^{7} nuclei in a metallic Li phase. It was concluded that irradiation causes some decomposition of LiF into its elements, L and F, and that many of the halogen defects are present as F gas in tiny cavities rather than as isolated interstitials in the lattice. In discussing the results, the role of halogen gas was emphasized; the observation of metallic Li supports the conclusions of previous studies which indicated the presence of colloidal Li. NMR lines representing colloidal Li were observed in only 2 specimens; both of these had received doses greater than 10^{19} nvt and contained large gas concentrations. A weak line in the Li^{7} NMR spectrum [frequency shift of $(1.6 \pm 0.3) \times 10^{-4}$ with respect to the ionic Li resonance] was tentatively identified as due to Li metal in the metastable face-centered cubic phase. Exploratory experiments on NaF and CaF_2 demonstrated that a fast-neutron irradiation of 10^{19} nvt can, on occasion, produce F gas concentrations comparable to those found for LiF. This result shows that decomposition is not limited to LiF. (M.P.G.)

16112 PROCESS FOR THE PREPARATION OF GRAFT POLYMERS. Charles Arthur Levine (to Dow Chemical Co.). British Patent 919,188. Feb. 20, 1963. Filed Feb. 3, 1961.

A process is provided for the manufacture of fiber or film-forming polymers of improved dyeability by graft polymerization of a minor quantity of one or more monomers to an acrylonitrile homopolymer or copolymer aquagel substrate. The aquagel substrate is impregnated with an N-vinyl heterocyclic monomer and then exposed to high energy ionizing radiation to initiate graft polymerization. The irradiated substrate is heated without irreversibly drying the aquagel to complete polymerization. (C.E.S.)

16113 POLYMERIZATION OF VINYL FLUORIDE. Peter Joseph Manno and William Henry Snaverly, Jr. (to Continental Oil Co.). British Patent 919,683. Feb. 27, 1963. Priority date May 18, 1960, United States.

A method of polymerizing vinyl fluoride is described. A dispersion of vinyl fluoride and a liquid in which the polymerized vinyl fluoride is insoluble is formed. The resulting emulsion is subjected to gamma radiation and the polymerized vinyl fluoride is recovered. (C.E.S.)

16114 CURING OF POLYMERIC COMPOSITIONS. Samuel Graham Ball and Denis Anthony Norman Osborne (to Dunlop Rubber Co. Ltd.). British Patent 919,823. Feb. 27, 1963. Filed Aug. 16, 1958.

A process for the treatment of a polymeric composition that was chemically cured at low temperatures is described. The composition is subjected to ionizing radiation until a substantial improvement in the mechanical properties of the composition is obtained. Examples of such methods include the use of an atmosphere of carbon disulfide at a temperature between 10 and 90°C for the curing of golf balls that have sulfur and a vulcanization accelerator incorporated in their covers. (C.E.S.)

16115 IRRADIATED POLYMERS. Gaetano F. D'Alelio. U. S. Patent 3,074,866. Jan. 22, 1963. Filed Jan. 6, 1958.

A process for producing improved polyester resins is presented. Linear, aliphatic, saturated polymeric esters are irradiated with at least 2 megareps of high-energy, ionizing radiation equivalent to at least 100 kev while in intimate contact with polyunsaturated polyester modifiers. The resulting product has greater solvent and heat resistance and better strength characteristics than the original polymer. The irradiated products can be hydrolyzed or saponified to give materials different from those of which the polyester resins were originally constituted. The specific polyester resins and polyunsaturated polyester modifiers that can be used are listed, and methods for combining the resins and modifiers and irradiating them are discussed. (M.P.G.)

16116 IRRADIATED PETROLEUM RESINS. James E. Shewmaker and Joseph F. Nelson (to Esso Research and Engineering Co.). U. S. Patent 3,074,867. Jan. 22, 1963. Filed Dec. 22, 1959.

A method for improving the properties of polymeric material produced by the Friedel-Crafts polymerization of light, cracked petroleum fractions is presented. The petroleum resins are mixed with a divinyl aromatic and irradiated at a dose rate of at least 0.1 equivalent Mr/hr until at least ½ equivalent Mr is absorbed. Resinous solids are obtained that have high softening points and are normally insoluble in common organic solids. Uses of the improved resin include solid-fuel binders for rocket propellants and as an impregnating material for paper board to make it impervious to moisture. The specific petroleum resins and divinyl aromatics that can be used and methods for making, mixing, and irradiating them are described. (M.P.G.)

16117 IMPROVEMENT IN HYDRODESULFURIZATION WITH AN IRRADIATED CATALYST. Lionel Domash and Richard A. Flinn (to Gulf Research and Development Co.). U. S. Patent 3,074,880. Jan. 22, 1963. Filed Dec. 30, 1958.

A process for hydrodesulfurizing hydrocarbons in the presence of a catalyst is described. The catalyst is nickel oxide combined with or mixed with tungsten oxide or molybdenum oxide and subjected to ionizing radiation. The irradiated catalyst reaches maximum activity more rapidly than an unirradiated one during hydrodesulfurization at temperatures between 550 and 725°F. (M.P.G.)

16118 IRRADIATED POLYMERS. Gaetano F. D'Alelio. U. S. Patent 3,075,904. Jan. 29, 1963. Filed Jan. 6, 1958.

A process for producing improved polyester resins is described. Linear, aliphatic, saturated polymeric esters are irradiated with at least 2 megareps of high-energy, ionizing radiation equivalent to at least 100 kev while in intimate contact with polyunsaturated polyalkenyl aryl modifiers. The resulting product has greater solvent and heat resistance and better strength characteristics than the

original polymer. The irradiated products can be hydrolyzed or saponified to give materials different from those of which the polyester resins were originally constituted. The specific polyester resins and polyunsaturated polyalkenyl aryl modifiers that can be used are listed, and methods for combining the resins and modifiers and irradiating them are discussed. (M.P.G.)

16119 IRRADIATED POLYMERS. Gaetano F. D'Alelio. U. S. Patent 3,075,905. Jan. 29, 1963. Filed Jan. 6, 1958.

A process for producing improved polyester resins is described. Linear, aliphatic, saturated polymeric esters are irradiated with at least 2 megareps of high-energy, ionizing radiation equivalent to at least 100 kev while in intimate contact with polyunsaturated polyether modifiers. The resulting products have greater solvent and heat resistance and better strength characteristics than the original polymer. The irradiated products can be hydrolyzed or saponified to give materials different from those of which the polyester resins were originally constituted. The specific polyester resins and polyunsaturated polyether modifiers that can be used are listed, and methods for combining the resins and modifiers and irradiating them are discussed. (M.P.G.)

16120 PROCESS FOR IRRADIATING PEARLS AND PRODUCT RESULTING THEREFROM. Ken-Tang Chow. U. S. Patent 3,075,906. Jan. 29, 1963. Filed June 15, 1960.

A process for irradiating natural or cultured pearls with high-energy radiation to a dosage of at least 4×10^5 r until a permanently fixed color change is effect is described. The irradiated pearls have more exotic coloring and therefore greater commercial value than before irradiation, and appear to be harder and of better quality. (M.P.G.)

16121 METHOD OF MAKING FLUORINATED COMPOUNDS. Paul Y. Feng (to Illinois Inst. of Tech.). U. S. Patent 3,081,243. Mar. 12, 1963. Filed Feb. 27, 1959.

A method is given for producing fluorinated aromatic compounds. The method comprises forming an intimate mixture of an aromatic compound and a covalently bonded fluoride compound, subjecting the mixture to high-energy ionizing radiation, and recovering a fluorinated aromatic compound. The fluoride compound may be one of the group of fluorinated hydrocarbons and fluorides of Si, P, B, As, Ti, S, and Se. The method is illustrated using the CF_4-C_6H_6 reaction, and the yields of C_6H_5F and $C_6H_5CF_3$ are plotted vs the CF_4/C_6H_6 ratio. (D.L.C.)

16122 PROCESS FOR POLYMERIZING UNSATURATED MONOMERS USING IONIZING RADIATION. Vincent A. Campanile (to Shell Oil Co.). U. S. Patent 3,081,244. Mar. 12, 1963. Filed Mar. 15, 1961.

A process is outlined for preparing high-molecular-weight polymers from unsaturated monomers, particularly unsaturated aldehydes such as acrolein. These polymers are colorless and water-insoluble but are soluble in aqueous SO_2, bisulfite, and basic solutions. The process comprises preparing an aqueous medium of the monomer and a small amount of a polysulfonic acid derivative of a polymer of an unsaturated aldehyde, and exposing the medium to high-energy ionizing radiation. The amount of the derivative in the medium is 0.01 to 10% by weight of the monomer. (D.L.C.)

Raw Materials and Feed Materials

16123 EXTRACTION OF URANIUM FROM ITALIAN URANIFEROUS MINERALS. Antonio Catino. Ann. Chim. (Rome), 52: 160-83(Feb.-Mar. 1962). (In Italian)

A study was made of the extraction technique based on the distribution of counter current of besimandite mineral with low uranium content. The method makes possible the extraction of uranium with a yield of 92% along with a mixture of acetylacetone and chloroform. (Rev. Metal Lit., 19: No. 6, 1962)

16124 THE TECHNOLOGY OF PRODUCING REACTOR GRADE URANIUM. Hans Martens. Freiberger Forschungsh., 64B: 111-29(1962). (In German)

Discussion is given on the production of reactor-grade uranium metal and alloys, sintered UO_2, sintered uranium carbide, and several other compounds including U_3O_8 and uranyl sulfate, by beneficiation of uranium ores, ion exchange, and liquid-liquid extraction, purification of concentrate obtained by liquid-liquid extraction, and refining and production of uranium compounds by wet and pyrometallurgical means. (Rev. Metal Lit., 19: No. 6, 1962)

16125 REDUCTION OF URANOSO-URANIC OXIDE BY DISSOCIATED AMMONIA. V. G. Vlasov and V. M. Zhukovskii (Kirov Polytechnic Inst., USSR). Zh. Prikl. Khim., 36: 42-7(Jan. 1963). (In Russian)

Kinetics of uranoso-uranic oxide reduction by dissociated ammonia at 450 to 650°C ($P_{3H_2+n} = 25$) indicated an activation energy of 32.2 ± 1.6 kcal/mole. The rate of the process was determined as a function of hydrogen pressure at constant temperature, $v = k \cdot P_{H_2}^{0.80 \pm 0.05}$. Water vapor inhibited the reduction. Kinetic studies and x-ray diffraction analysis revealed the following phase transformation scheme: $U_3O_8 \rightarrow U_3O_{8-x_{max}} \rightarrow U_4O_9 \rightarrow UO_{2+x_{max}} \rightarrow UO_{2+x}$. It was postulated that the surface reaction between adsorbed hydrogen and the oxygen of the oxide is the inhibiting factor in the reduction process. (R.V.J.)

16126 HARSHAW-TYPE BOMB (Engineering Materials). (Oak Ridge Gaseous Diffusion Plant, Tenn.). 1 drawing. (CAPE-948)

The bomb is used in shipping samples of uranium hexafluoride, is considered safe for any enrichment of U^{235}, and has a capacity of 2,250 g. The bomb is cylindrical in shape, 7½ in. high, ⅛ in. thick, and 3½ in. in dia. Filling is accomplished through an angle valve 3/8 M.P. × 1/2 SAE. (F.L.S.)

16127 PROCESS FOR THE PREPARATION OF GRANULAR URANIFEROUS MATERIAL. (to Stichting Reactor Centrum Nederland). British Patent 919,523. Feb. 27, 1963. Priority date May 14, 1958, Netherlands.

A process for preparing granular uraniferous material is described. A homogeneous aqueous solution is formed free of precipitation and containing nitrate ions, uranyl ions, and urea. The solution is maintained at an elevated temperature so that the uraniferous material precipitates. (C.E.S.)

16128 ROTARY KILN APPARATUS FOR THE TREATMENT OF CHEMICAL COMPOUNDS. (to Nuclear Materials and Equipment Corp.). British Patent 921,654. Mar. 20, 1963. Priority date, Mar. 13, 1959, United States.

A rotary kiln apparatus is designed for the treatment of solid material with dangerous gases or in such a way that dangerous gases may be emitted. The apparatus is especially suited for carrying out the conversion of UO_3 or U_3O_8 into UO_2 by H_2 reduction. The apparatus comprises a container through which the solid material is to be fed, means for rotating the container, and a static gas-tight enclosure surrounding the container. The rotating means includes a gas-tight bearing, and a shaft driving the container and journaled in the bearing. (D.L.C.)

16129 METHOD FOR THE CONTINUOUS PRODUCTION OF URANIUM DIOXIDE. (to Nuclear Materials and

Equipment Corp.). British Patent 921,655. Mar. 20, 1963. Priority date, Mar. 13, 1959, United States.

A method is given for the continuous production of uranium dioxide by hydrogen reduction of higher oxides. The method comprises feeding the granular, higher oxides in one direction and flowing hydrogen through the oxides in the opposite direction. Fluorides are removed by reaction with water vapor. A rotary kiln for use with this method is described. (D.L.C.)

16130 PROCESS FOR EXTRACTION OF THORIA AND CERIA FROM RARE EARTH ORES. Ian C. Kraitzer (to Associated Minerals Consolidated Ltd.). Canadian Patent 653,179. Nov. 27, 1962. Priority date Oct. 12, 1959, Australia.

Extraction of ceria and thoria from rare earth ores containing cerium and thorium is performed by digesting the ores to yield hydroxides of lanthanons and thorium that are subjected to alkaline bleach under controlled conditions. (D.C.W.)

16131 APPARATUS AND METHOD FOR EFFECTING CONTINUOUS SOLID-GAS REACTIONS. Paul Vertes, Henri Huet, and Maurice Delange (to Commissariat à l'Énergie Atomique). Canadian Patent 655,287. Jan. 1, 1963. Priority date Nov. 28, 1960, France.

A system of horizontal and vertical tubular coolers and furnaces and an allied procedure permit continuous reduction of UO_3 to UO_2 with predetermined characteristics. Constant control of the reaction is possible at each stage. (D.C.W.)

16132 METHOD FOR PRODUCING UO_2 POWDER. F. Hofmann and F. Ploeger (to Nuklear-Chemie and Metallurgie GmbH). German Patent DAS 1,142,852. Jan. 31, 1963. Filed Oct. 19, 1961.

A method is given for producing UO_2 powder comprising the steps of precipitating UO_2 from a solution of uranyl nitrate, with the help of hydrogen peroxide, neutralizing free acid by adding ammonia, and calcinating and reducing the powder. The UO_2 powder produced by this method is especially suited for the fabrication of fuel elements by hammer-treatment. (Gmelin Institute)

16133 FRACTIONAL PRECIPITATION OF URANIUM FROM URANIUM–VANADIUM CONTAINING CARBONATE LEACH SOLUTION. Robert A. Koble (to Phillips Petroleum Co.). U. S. Patent 3,078,141. Feb. 19, 1963. Filed Dec. 31, 1959.

A method is given for increasing the purity of yellow cake produced in the carbonate leaching process of recovering U from ores. The method comprises fractionally precipitating the soluble U values in the pregnant carbonate leach liquor in at least two steps. The yellow cake obtained in the initial steps is relatively pure, and the cake obtained in the last step can be oxidized at high temperatures to convert the V values to a water-soluble vanadate. (D.L.C.)

16134 APPARATUS FOR PRODUCTION OF URANIUM. Donald R. Allen and Anneke S. Allen (to Dow Chemical Co.). U. S. Patent 3,079,324. Feb. 26, 1963. Filed June 30, 1958.

An improved electrolytic cell is designed for the continuous production of U metal and Cl_2 gas. The electrolyte is a fused salt mixture of 1 part of an alkali metal uranous fluoride and 1 to 2 parts of an alkali metal chloride. In the electrolysis process, depleted electrolyte is gradually withdrawn and replaced with makeup electrolyte. (D.L.C.)

16135 CONTROL OF CARBONATE CONCENTRATION IN CARBONATE LEACHING OF URANIUM-BEARING ORES BY CALCIUM SULFATE ADDITION. Robert A. Koble (to Phillips Petroleum Co.). U. S. Patent 3,081,147. Mar. 12, 1963. Filed Dec. 18, 1959.

A method is given for controlling the carbonate concentration of the leach solution in order to prevent it from pyramiding and exceeding the optimum range at which uranium is best leached. The method comprises adding $CaSO_4$ as the anhydride or dihydride to the leach solution in an amount sufficient to keep the pH at ~10 and the Na_2CO_3 concentration at ~30 g/l. The $CaSO_4$ reacts with the excess Na_2CO_3 to precipitate $CaCO_3$, which is removed when the slurry of leached pulp and pregnant leach liquor is filtered. (D.L.C.)

16136 INHIBITION OF POST PRECIPITATION OF URANIUM IN BARREN LIQUOR OF CARBONATE LEACHING PROCESS. John C. Hillyer and James L. Hart (to Phillips Petroleum Co.). U. S. Patent 3,081,148. Mar. 12, 1963. Filed Dec. 21, 1959.

A small amount of U is not separated in the caustic precipitation of U in the carbonate leach solution and tends to collect on the pulp filters together with the tailings when the barren liquor is used as wash liquid prior to regeneration and recycle. A method for preventing this post-precipitation until after regeneration comprises treating the barren liquor with H_2O_2 in an amount of 0.3 to 1 g/g U_3O_8. (D.L.C.)

16137 CATALYZING THE OXIDATIVE LEACHING OF URANIUM WITH NICKEL AMMONIUM SULFATE. Frank C. Haas (to Phillips Petroleum Co.). U. S. Patent 3,081,149. Mar. 12, 1963. Filed Dec. 31, 1959.

The oxidative leaching of the lower oxidation states of U in the carbonate leaching of ores can be catalyzed by nickel ammonium sulfate. The catalyst preferably is added to the thickener underflow in an amount ranging from 0.1 to 10 lb/ton ore, and the oxidation is carried out using O_2. Several examples of the use of the catalyst are given. (D.L.C.)

Separation Processes

16138 (AE-103) ANION-EXCHANGE STUDIES OF RADIOACTIVE TRACE ELEMENTS IN SULPHURIC ACID SOLUTIONS. K. Samsahl (Aktiebolaget Atomenergi, Stockholm). Jan. 1963. 12p.

A study was made of the adsorption from sulfuric acid solutions on strongly basic hydroxide and sulfate anion exchange resins, of Na, P, K, Ca, Sc, Cr, Mn, Fe, Co, Ni, Cu, Zn, Ga, Rb, Sr, Zr, Nb, Mo, Tc, Ag, Cd, In, Cs, Ba, La, Ce, Hf, Ta, W, Ir, Pa, and Np traces. Besides adsorbing some of the trace elements in the solution, the anion-exchange resin in the hydroxide form will neutralize the bulk of the sulfuric acid. This makes possible the subsequent sequential separation of chloride complexes on short anion-exchange columns by a stepwise increasing of the HCl concentration of the solution. On the basis of the results obtained in the present and earlier experiments, a new improved chemical group-separation procedure for mixtures of radioactive trace elements is outlined. (auth)

16139 (AERE-R-4245) THE AMP PROCESS FOR CAESIUM SEPARATION. IV. TOWARDS A FLOWSHEET. J. van R. Smit, J. J. Jacobs (Union of South Africa. Council for Scientific and Industrial Research. National Chemical Research Lab., Pretoria); and F. C. W. Pummery (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1963. 38p.

A process is described for the production of Cs^{137} from fission product waste concentrates, utilizing the inorganic ion exchangers ammonium 12-molybdophosphate (AMP) and zirconium phosphate (ZP). Cesium is preferentially adsorbed on columns of coarse particles of AMP, followed

by washing with dilute nitric acid. This quantitatively removes all other activities except some $Zr^{95}-Nb^{95}$. Recovery of the cesium is achieved by dissolving the loaded AMP column in caustic soda, removing the small precipitate and neutralizing to pH 4, followed by separation of cesium from sodium on the ZP column. Cesium is finally recovered from the latter by elution with hydrochloric acid. A production rate of 10 megacuries per annum (300 working days) would require daily a column of AMP having a volume of about 15 liters. Two or three similar columns of ZP, which are used repeatedly, are required for the cesium–sodium separation. The principal advantages of the method over others such as recrystallization and precipitation are: small size of equipment, leading to a great reduction in shielding requirements, and simplicity of operation; adaptability to virtually any waste composition or concentration; no non-volatile, and little volatile materials are added to the waste; and prior neutralization of the waste is not necessary. The cesium chloride produced has a high chemical and radiochemical purity. (auth)

16140 (DP-757) A MINIATURE PILOT PLANT FOR PROCESSING IRRADIATED NUCLEAR FUEL. Carl S. Schlea, Myron R. Caverly, Hugh E. Henry, Edward C. Horni, and William J. Jenkins (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Nov. 1962. Contract AT(07-2)-1. 51p.

The Savannah River Laboratory facility for studying the solvent extraction processing of irradiated fuels is equipped to perform dissolving, precipitation, solvent extraction, and auxiliary operations on a scale about 1/50,000 of plant scale equipment. Shielding and containment are designed for a maximum of 20,000 curies of gamma radioactivity and/or several grams of Pu^{239}. The division of the facility into processing units, the uses for each unit, and the equipment in each unit are discussed. (auth)

16141 (HW-68442) CAC-880 Pu RECLAMATION FACILITY — Z PLANT GLOVE BOX DESIGN STUDY. G. P. Kesel and R. C. Baker (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 13, 1961. Contract AT(45-1)-1350. 33p.

Design studies for the Plutonium Reclamation Facility called for the main process equipment to be mounted on walls of a canyon cell with all piping from each vessel brought out through plugs in the 2-ft-thick concrete wall to a shielded glove box hood where all interconnecting equipment such as piping, valves, controls, and pumps are located. The space requirements precluded designing the main process glove boxes with the size limitations recommended by the initial study. Therefore, a study was made to extend the size of the hoods. Recommendations are given for glove-box depth, maximum distance from glove ports to top or bottom of hood, horizontal glove port spacing, viewing windows and their location, vertical spacing of glove ports, working and equipment location areas with the hoods, and required platform heights. (M.C.G.)

16142 (IDO-14602) PHYSICAL PROPERTIES OF NITRATE SOLUTIONS OF IRON- AND NICKEL-BASE ALLOY NUCLEAR FUELS. D. P. Pearson (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 31, 1963. Contract AT(10-1)-205. 13p.

Specific gravity, viscosity, electrical conductivity, and stability data are given for the dissolver product solutions resulting from the electrodissolution in nitric acid of nuclear fuels with stainless steel or Nichrome cladding. (auth)

16143 (LADC-5377) THE PROCESSING OF PLUTONIUM BY ION EXCHANGE. I. THE CONCENTRATION DEPENDENCE OF DISTRIBUTION COEFFICIENTS ON DOWEX 1X4 FROM 7M NITRIC ACID. D. B. James (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract W-7405-eng-36. 21p.

An expression was derived and experimentally confirmed for the change in the volume distribution coefficient for Pu(IV) on Dowex 1X4 from 7M HNO_3 with varying concentrations of Pu(IV) in the aqueous phase. A few experiments with other sorbable species indicate the equations may be applicable to other systems. These calculations require one measurement of the volume distribution coefficient at a trace level of resin loading. These trace level coefficients were determined for many elements. (auth)

16144 (NLCO-867) ROLE OF INORGANIC SURFACTANTS IN LIQUID-LIQUID EXTRACTION SYSTEMS. Thomas J. Collopy and John H. Mueller (National Lead Co. of Ohio, Cincinnati). Mar. 14, 1963. Contract AT(30-1)-1156. 25p.

Gravity uranium concentrate from Port Radium, Canada was demonstrated in both laboratory and pilot plant tests to have beneficial surface-active properties in both new and used tri-n-butyl phosphate extraction systems. The minerals Niccolite (NiAs) and Rammelsbergite ($NiAs_2$) were demonstrated to be the agents in the concentrate responsible for the surface active properties exhibited by this uranium ore. The synthesis of nickel arsenides from the component elements was shown to be feasible. (auth)

16145 (ORNL-3312) RECOVERY OF IRRADIATED URANIUM BY A TWO-STAGE DIFFERENTIAL EXTRACTION PROCEDURE. R. E. McHenry, J. C. Posey, and P. S. Baker (Oak Ridge National Lab., Tenn.). Mar. 21, 1963. Contract W-7405-eng-26. 33p.

The recovery of uranium from irradiated fuel and its simultaneous separation from fission products can be effected by a differential extraction procedure which requires only two stages. Tributyl phosphate is used as the organic extractant, and sulfate ion is used as a complexing agent in the aqueous phase to enhance separation of uranium from fission products. In the first stage, sufficient extractant is used to obtain the required recovery of uranium. In the second stage, the extractant phase from the first cycle contains the uranium and a small portion of the fission products, and has now become the solvent phase. Sufficient aqueous extractant (3M HNO_3 and 1M H_2SO_4) is used in the second stage to obtain the required decontamination. The extracted uranium is then recycled to the first stage. In a system employing a 30% TBP-Amsco organic phase and a 3M HNO_3–1M SO_4^{2-} aqueous phase, a separation factor between uranium and zirconium-niobium of >1200 was obtained. This value was constant throughout the first stage. The separation factor between uranium and zirconium-niobium in the second stage was >600. The separation factor for uranium and europium varied from 2500 to 400, depending upon the extent of uranium saturation in the organic phase. The separation factor for uranium and ruthenium was >5000. In one program, 15 kg of uranium was recovered with an overall efficiency greater than 99.5%. Decontamination factors were $>1 \times 10^6$. The decontamination factor between uranium and zirconium-niobium was approximately 1×10^4. (auth)

16146 (ORNL-TM-527) SURVEY OF RECENT DEVELOPMENTS IN SOLVENT EXTRACTION WITH TRIBUTYL PHOSPHATE. R. E. Blanco, C. A. Blake, Jr., W. Davis, Jr., and R. H. Rainey (Oak Ridge National Lab., Tenn.). Mar. 21, 1963. Contract [W-7405-eng-26]. 39p.

Tributyl phosphate can be used for extraction in processing all current power reactor fuels. Nitric acid is the only salting agent required. Typical flowsheets are presented. In aluminum nitrate systems which are more than 0.1 M acid deficient, the uranium distribution coefficient is a function of pH and independent of aluminum concentration; the coefficient remains constant at one in fluoride systems when the nitrate to fluoride ratio is ~3.5. Many objectionable properties of degraded diluents are ascribed to nitroparaffins. Aliphatic diluents with the least branching are the most stable to nitration. The nitration stability of aromatic diluents varies with structure, e.g., stabilities of diethylbenzenes decrease as meta ≫ ortho > para. Solvent purification by flash distillation appears superior to other methods. The stability of Amsco 125-82 was permanently improved by treatment with sulfuric acid. The radiation stability of TBP was ~2 times higher in an aromatic diluent than in Amsco 125-82. The G decomposition value for 1 M TBP in Amsco alone was ~0.9; whereas in 1 to 3 M HNO_3 it was 1 to 5 and G ($-HNO_3$ org phase) was 3 to 20. Variation of uranium–thorium separation factors with structure of some neutral organophosphorus reagents is presented. Basic studies include measurement of activities in multicomponent solutions and description of aqueous activity coefficients by an extended Debye-Hückel equation. (auth)

16147 (VDIT-68) EXTRACTION OF URANIUM. A Literature Survey. M. Seleborg (Aktiebolaget Atomenergi, Stockholm). Feb. 15, 1963. 24p.

Sixty references with abstracts are included for publications dealing with solvents used for uranium extraction. The references, that exclude articles on the use of amines or TBP, are arranged in chronological order for 1958-1962. Nuclear Science Abstracts supplemented current periodicals as a source of information. (D.C.W.)

16148 (VDIT-70) SEPARATION OF HEXAVALENT URANIUM FROM AQUEOUS SOLUTIONS BY ANION EXCHANGE. A Literature Survey. Madeleine Seleborg (Aktiebolaget Atomenergi, Stockholm). Feb. 1963. 57p.

A literature survey on the separation of U(VI) from aqueous solutions by ion exchange is presented. The 167 abstracts covering the period 1951 to 1962 are arranged in chronological order. Subdivisions for reports, journals, and patents are included. (M.C.G.)

16149 (CEA-tr-A-1230) ADSORPTION DE TERRES RARES RADIOACTIVES PROVENANT DE NITRATES FONDUS SUR L'ALUMINE ET LE VERRE PYREX. (Adsorption of Radioactive Rare Earths from Molten Nitrates on Alumina and Pyrex Glass). R. Lindner and S. Johnsson. Translated into French from Z. Elektrochem., 64: 1063-5(1960). 8p.

The separation of rare earths dissolved in fused $LiNO_3$/KNO_3 on columns of finely granulated alumina (standard Brockmann preparation) and pulverized pyrex glass was proved by separating La^{140} from Nd^{147}, Tb^{160}, and Tm^{170}. The higher lanthanides are preferentially adsorbed, which is in agreement with the adsorption from aqueous solutions. (tr-auth)

16150 (CEA-tr-A-1291) SÉPARATION ÉLECTROLYTIQUE ET ÉLECTROCHIMIQUE DU RADIUM D, RADIUM E ET DU POLONIUM À PARTIR D'UNE SOLUTION D'ÉTHYLÉNÉDIAMINE TRÉTAACÉTATE. (Electrolytic and Electrochemical Separation of Radium D, Radium E, and Polonium Starting with a Solution of Ethylenediamine Tetraacetate). Vlastimil Vebersik. Translated into French from Z. Anal. Chem., 175: 405-15 (1960). 26p.

A method for the electrolytic and electrochemical separation of RaD and RaE and of Po from ethylenediamine tetraacetic acid is described. The effect of the electrode nature on the efficiency of the separation is determined. (J.S.R.)

16151 LABORATORY COUNTERCURRENT EXTRACTION IN THE MIXER-SETTLER. II. EXTRACTION OF URANYL NITRATE AND NITRIC ACID BY MEANS OF METHYLCYCLOHEXANONES IN ACID AND ACID-POOR MEDIA. V. Šraier (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Rez). Collection Czech. Chem. Commun., 28: 36-45(Jan. 1963). (In German)

The distribution of uranyl nitrate and nitric acid in countercurrent extraction by methylcyclohexanones in acid and acid-poor media in a 10-stage mixer-settler was investigated on laboratory scale. The initial concentrations of uranyl nitrate in the aqueous phase amounted to 1 and 2M both in the acid and in the acid-poor extraction. For salting out, 5M NH_4NO_3 was used in all cases. The methylcyclohexanones acidified in various ways was introduced entirely at the end or in part in the middle. The conditions were sought that would guarantee the most effective extraction of uranium and good utilization of the extraction means at the same time. (tr-auth)

16152 INVESTIGATION OF ION-EXCHANGE REACTIONS IN HYDROFLUORIC ACID SOLUTIONS. GROUP SEPARATION OF ELEMENTS BY MEANS OF ION-EXCHANGE RESINS. M. K. Nikitin (Leningrad State Univ.). Dokl. Akad. Nauk SSSR, 148: 595-7(Jan. 21, 1963). (In Russian)

In order to determine the best condition for the chromatographic separation of elements from HF solutions, their absorption by ion-exchange resins was studied. Highly stable monosulfide resins were used for the tests. Pure radioisotopes of the elements studied were used as indicators; the initial concentrations did not exceed 10^{-8} g/ml. The distribution coefficients were determined under static conditions. Results indicated the possibility of separating the elements by groups. Complex fission product mixtures prepared by the irradiation of Ta, Hf, W, and U targets with 660-Mev protons were successfully separated; the method used involved dissolution of the target in concentrated HF containing some HNO_3, then passing the diluted solution through the actionite resin which sorbs quantitatively the rare-earth elements, alkalis, alkaline earths, and other elements which do not form anions under these conditions; therefore Ta, Hf, W, and U were not sorbed. For U, a purification (decontamination) factor of about 10^5 was obtained. (TTT)

16153 ACID LEACHING OF URANIUM FROM SOME SOUTH DAKOTA LIGNITES. Shiou-Chuan Sun and J. W. Fetterman (Pennsylvania State Univ., University Park and New Jersey Zinc Co., Palmerton). Indian J. Technol., 1: 120-3(1963).

The effect of acid concentration, leaching time, oxidation, rate and mode of agitation, temperature, and pulp density on the recovery of U from three samples of U-bearing lignites from South Dakota with high, intermediate, and low U contents was studied. The recovery of U increased with increase in acid concentration, leaching time, extent of aeration, and rate of agitation. Addition of 1.0 mole per liter of H_2O_2, $KMnO_4$, or MnO_2 into the leaching pulp raised the U recovery to 95%. (auth)

16154 THE EXTRACTION OF Pu(IV) NITRATE BY LONG CHAIN TERTIARY AMINES NITRATES. F. Baroncelli, G. Scibona, and M. Zifferero (CNEN, Rome). J. Inorg. Nucl. Chem., 24: 541-6(Nov. 1962).

The acid dependence of the partition coefficient of Pu(IV)

nitrate into organic solutions of long chain tertiary aliphatic amine nitrates is attributed to the different extraction behavior of the Pu complexes, which are formed in the aqueous phase at different nitric acid concentration. Of the several possible plutonium nitrate complexes only $Pu(NO_3)_4$ and $Pu(NO_3)_6^{2-}$ can undergo extraction to a useful extent. Spectrophotometric data, ion exchange absorption, and solid $Pu(NO_3)_4$ solubility experiments support this interpretation. The plutonium species predominating in the organic phase was confirmed to be $(R_3N)_2Pu(NO_3)_6$ under a wide variety of experimental conditions. (auth)

16155 THE EXTRACTION OF HEXAVALENT URANIUM FROM NITRIC ACID SOLUTIONS BY TRI-n-DODECYLAMINE NITRATE. F. Baroncelli, G. Scibona, and M. Zifferero (CNEN, Rome). J. Inorg. Nucl. Chem., 24: 547-59(Nov. 1962).

Solutions of tertiary amine nitrates behaved like liquid anion exchangers in the extraction of uranyl nitrate from aqueous solutions. The extraction mechanism is based on the formation of anionic uranium complexes in the aqueous phase which undergo extraction: $UO_2(NO_3)_{2+n}^{n-} + n[R_3NH^+NO_3^-]^0 \rightleftharpoons [(R_3NH^+)_nUO_2(NO_3)_{2+n}^{n-}]^0 + nNO_3^-$. The uranium partition coefficient increases at increasing nitric acid molarities in the aqueous phase, reaches a maximum at approximately 6M HNO_3, then decreases. This behavior is explained as due to the presence of different types of uranium complexes in the aqueous phase. Below 6M HNO_3 the extractable species $UO_2(NO_3)_{2+n}^{n-}$ is predominating; above 6M HNO_3 the inextractable $HUO_2(NO_3)_3$ complex prevails as indicated by absorption spectra and ion exchange behavior. Different values of n, ranging from 1 to 1.7 were found depending on salting strength, uranium and nitric acid concentration. The influence of the organic phase composition was studied by directly dissolving solid uranyl nitrate in the amine solvent. No difference was detected in the absorption spectra and ion exchange behavior between the uranium loaded organic phase obtained by extraction and the one obtained by solid UNH solubilization. Results of solubility experiments seem to exclude an extraction mechanism based on the stepwise complex formation of an amine polynitrate. (auth)

16156 EXTRACTION OF TETRA- AND HEXAVALENT ACTINIDES FROM HYDROCHLORIC ACID BY TRI-n-OCTYLAMINE IN XYLENE. W. E. Keder (General Electric Co., Richland, Wash.). J. Inorg. Nucl. Chem., 24: 561-70(Nov. 1962).

Distribution data for extraction of the tetra- and hexavalent actinides from hydrochloric acid by tri-n-octylamine (TOA) solutions are reported and the spectra of the extracted complex ion species are shown. The hexachloro complexes of the tetravalent metals were found to extract. The data also indicate the extraction of the tetrachloro actinyl ions, but the identity of these ions was not fully established. (auth)

16157 THE EXTRACTION OF LANTHANONS WITH ALKALI METAL AMALGAMS. I. SAMARIUM AND YTTERBIUM. M. F. Barrett, D. Sweasey, and N. E. Topp (National Chemical Lab., Teddington, Middx., Eng.). J. Inorg. Nucl. Chem., 24: 571-86(Nov. 1962).

The extraction of samarium and ytterbium from solutions of lanthanon concentrates with sodium amalgam was studied, using a dropwise extraction procedure. The reproducibility of the method was established. Extraction of the elements depends on the samarium or ytterbium content of the lanthanon concentrate used, and also on the pH of the solution. Under certain conditions marginal quantities of other lanthanons are extracted. Mechanisms of the reaction are discussed. (auth)

16158 MUTUAL SEPARATION OF URANIUM, PLUTONIUM AND FISSION PRODUCTS BY GRADIENT MULTISTAGE EXTRACTION. Tomitaro Ishimori and Johkun Akatsu (Japan Atomic Energy Research Inst., Tokyo). Radiochim. Acta, 1: No. 1, 11-15(Sept. 1962). (In English)

Uranium, plutonium, and fission products are separated by means of a multistage extraction of 20% TBP-carbontetrachloride vs nitric acid series. In order to enhance the mutual separation, the acidity of the aqueous portions is lowered stepwise. All fission products, plutonium, and uranium are obtained in aqueous solutions in the sequence mentioned, leaving no active material in the organic solutions of the extractor. The plutonium fractions contain some fission products and a small amount of uranium. However, uranium is obtained with a fairly high purity. The same organic solutions can be used several times giving more or less the same separated products. (auth)

16159 SEPARATION OF NATURAL RADIONUCLIDES BY MEANS OF AMMONIUM MOLYBDATOPHOSPHATE ON PAPER SUPPORT. Heinrich J. Schroeder (Kernforschungszentrum, Karlsruhe, Ger.). Radiochim. Acta, 1: No. 1, 27-31(Sept. 1962). (In German)

Carrier-free thallium (Tl^{207} = AcC″, Tl^{208} = ThC″) and francium (Fr^{223} = AcK) were separated from the mixtures of radionuclides occurring in natural radioactive families. Ammonium molybdatophosphate, supported on paper in a thin layer, was used as an ion exchanger. The methods used were either chromatography or filtration. They have the advantage of being simple and rapid. (auth)

16160 NEW PROCESS FOR ISOLATION OF Fr-223 ON SYNTHETIC ULTRAMARINE BY USE OF A SIEVE EFFECT. W. Herr and H. J. Riedel (Universität, Cologne and Kernforschungsanlage, Julich, Ger.). Radiochim. Acta, 1: No. 1, 32-5(Sept. 1962). (In German)

An ion-sieve effect on a synthetic ultramarine caused a decrease of the exchange of the alkali-metal elements from sodium to francium depending on the bare ionic radii. Ac^{227} was strongly adsorbed by ultramarine together with Th^{227}, Po^{215}, and Pb^{211}, whereas Tl^{207} and Ra^{223} were eluted together with Fr^{223}. From this eluate Ra^{223} was adsorbed on a $BaSO_4$-silica bed which was coupled to the ultramarine-column. By this technique it was possible to separate Fr^{223} with a high yield of ~90% in the short time of 2 to 3 min. Any remaining part of short-lived Tl^{207} may be eliminated by a Tl + precipitation, but this procedure does not take more than 3 min. It was found that even after 8 months, Fr^{223} could still be milked repeatedly from the radiation resistant ultramarine column without any change in the yield. The K_D-values of francium on ultramarine are reported together with those from the alkali and alkaline earth ions, and Y^{3+} and Sc^{3+}. Additionally the K_D-values of Fr were determined on Zirconium phosphate, tungstate, and molybdate and compared with the corresponding Cs-K_D-values. (auth)

16161 THE ANALYTICAL APPLICATION OF FLUORIC ION. III. SOLVENT EXTRACTION OF THORIUM. Jisuke Seki. Rika Gaku Kenkyusho Hokoku, 38: 334-41(1962). (In Japanese)

16162 THE ANALYTICAL APPLICATION OF FLUORIC ION. IV. SOLVENT EXTRACTION OF THORIUM IN FLUORIDE. Jisuke Seki. Rika Gaku Kenkyusho Hokoku, 38: 342-7(1962). (In Japanese)

16163 THE ANALYTICAL APPLICATION OF FLUORIC ION. V. METHOD OF SEPARATING THORIUM FROM RARE EARTH ELEMENTS. Jisuke Seki. Rika Gaku Kenkyusho Hokoku, 38: 348-53(1962). (In Japanese)

16164 VITRO CHEMICAL RECOVERS COSTLY SCANDIUM FROM URANIUM SOLUTIONS. L. D. Lash and J. R. Ross. Trans. AIME, 220: 430-3(1961).

The spectrographic and chemical assaying and solvent-extraction recovery of Sc values in uranium ore leach liquors are presented. (Rev. Metal Lit., 19: No. 6, 1962).

16165 MATHEMATICAL MODEL FOR SOLVENT EXTRACTION OF Hf AND Zr WITH TRIBUTYL PHOSPHATE. Yu. V. Granovskii, N. A. Chernova, Yu. P. Adler, V. V. Nalimov, L. N. Komissarova, and V. I. Spitsyn (Moscow State Univ. and State Research and Design Inst. of Rare Earth Industry, USSR). Zavodsk. Lab., 29: 60-5(1963). (In Russian)

A mathematical method for planning a matrix and resolving metallurgical problems was tested in solvent extraction experiments on Hf and Zr using TBP. A mathematical model was found for an improved separation. (tr-auth)

16166 DETERMINATION OF OPTIMUM CONDITIONS IN THE EXTRACTION OF MICROQUANTITIES OF Hf WITH TRIBUTYL PHOSPHATE. L. N. Komissarova, Yu. V. Granovskii, N. M. Prutkova, Yu. P. Adler, V. V. Nalimov, and V. I. Spitsyn (Moscow State Univ. and State Research and Design Inst. of Rare Earth Industry, USSR). Zavodsk. Lab., 29: 65-8(1963). (In Russian)

The distribution coefficient for Hf extraction from nitric acid solutions by TBP was increased by an order of 4 in tests using a sharp ascension method. (tr-auth)

16167 METHOD FOR DISSOLVING ZIRCONIUM–URANIUM COMPOSITIONS. (to U. S. Atomic Energy Commission). British Patent 920,113. Mar. 6, 1963. Priority date Mar. 7, 1960, United States.

A method is described for treating U–Zr alloys and Zr-alloy-clad U alloys to form a stable solution, from which uranium and other elements may be extracted. (C.E.S.)

16168 PROCESS FOR SEPARATING YTTRIUM AND RARE EARTHS. Kazimierz Jozef Bril and Pawel Krumholz. U. S. Patent 3,078,142. Feb. 19, 1963. Priority date Sept. 2, 1957, Brazil.

A simple, highly efficient process for separating Y from the terbium rare earths is described which is based on the fractional precipitation of potassium and/or ammonium double chromates. The process comprises forming a concentrated solution of Y and rare earths of 100 to 200 g/l, adding bichromate in excess of at least 0.02 mole/l, precipitating the rare earths with K_2CrO_4, KOH, K_2CO_3, $KHCO_3$, $(NH_4)_2CrO_4$, NH_4OH, NH_3, $(NH_4)_2CO_3$, or NH_4HCO_3 at 45 to 85°C, and recovering the Y from the remaining solution. The solution should contain less than 3 moles/l of nitrates, and the precipitation should be carried out in steps to increase the efficiency of the process. (D.L.C.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstract 17337.

16169 (AD-282462) LUBRICANTS AND BEARINGS AT ULTRA-HIGH TEMPERATURES. A PARTIALLY ANNOTATED BIBLIOGRAPHY. (North American Aviation, Inc. Space and Information Systems Div., Downey, Calif.). Jan. 17, 1962. 28p.

A survey of the unclassified literature from 1959 through 1961 on friction, lubrication, and bearings at temperatures above 1200°F is presented. (auth)

16170 (AECL-1662) A PHOTOELASTIC STUDY OF METALLIC SEALS. A. W. L. Segel (Atomic Energy of Canada Ltd., Chalk River, Ont.). July 1962. 25p.

The load-deflection and maximum stress-deflection characteristic curves for various metallic seals were determined using two-dimensional photoelastic models. The results are presented on dimensionless graphs and are, therefore, directly applicable to any seal or similar cross section. The validity of the results was reasonably well established by two tests. The load-deflection curve for a metallic seal was determined and found to agree with that of the geometrically similar model. The yield stress of the metal was also determined from the model results and found to agree closely with the accepted value. The stress distribution, due to closure loading only, used for the two-dimensional models was compared to the stress distribution in a three-dimensional model loaded as a metallic seal would be by closure and internal pressure. The stress distributions were similar indicating that the closure loading two-dimensional study is adequate for the selection and design of metallic seals to be used in high-temperature, high-pressure applications. (auth)

16171 (ANL-6489) THE FACILITY 350 HELIUM-ATMOSPHERE SYSTEM. Final Report, Metallurgy Division Program 1.5.5. R. M. Mayfield, W. G. Tope, and A. B. Shuck (Argonne National Lab., Ill.). Dec. 1962. Contract W-31-109-eng-38. 45p.

The He atmosphere system in Argonne's Facility 350 is described in detail. The system is straightforward, employing drying and carbon towers for the removal of moisture, oxygen, and other impurities. The bulk of the 15,000 ft^3 of He atmosphere is continuously recirculated at nearly atmospheric pressure. Purification is accomplished at 140 psig on a portion of the gas that is passed through the drying tower at room temperature and the carbon towers at −46°C (−50°F). The operation is continuous, requiring a minimum of maintenance and operational manpower. The He atmosphere is supplied to the glove-boxes with impurity levels below 3,000 ppm nitrogen, 1,000 ppm oxygen, and 50 ppm moisture. Such purity levels prevent oxidation and combustion of the Pu materials being processed. Experimental data concerning the adsorption of oxygen from He by activated carbon over a range of temperature and pressure conditions are reported. (auth)

16172 (BNL-6796) FUNDAMENTALS OF VACUUM TECHNOLOGY. C. L. Gould (Brookhaven National Lab., Upton, N. Y.). Feb. 15, 1963. Contract [AT(30-2)-Gen-16]. 28p.

Capabilities and operational principles of the various vacuum gages and pumps are surveyed. (D.C.W.)

16173 (KAPL-M-JVM-4) BEAM I: BEAMS ON ELASTIC FOUNDATIONS. Julius A. Mirabal and Judith K. Van Voorhis (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 1962. Contract W-31-109-eng-52. 74p.

A computer program, BEAM I, to be used in the stress analysis of beam structures loaded by forces in the plane of the structure was derived. Concentrated forces and three dimensional elastic supports may be specified at one end of each beam segment and the loading along the beam is assumed to be a uniformly distributed force. Corrections for shear deflection are included. The program solves numerically for the stresses, deflections, and forces in a series of prismatic beam segments and allows a mismatch and an angle at the junction of two segments. The maximum number of segments for a single case is 100. Nature of the input and output data is discussed, and sample problems are shown. (auth)

16174 (LADC-5418) AN ELECTRICAL FLUX PUMP FOR POWERING SUPERCONDUCTING MAGNET COILS. Henry L. Laquer (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 11p.

A method is described which allows stepwise flux accumulation in superconducting magnet coils. A maximum field of 5.4 koe achieved with one coil corresponds to a current of 1070 amperes. (J.R.D.)

16175 (LAMS-2799) A BRIEF SURVEY OF PRODUCTION TECHNIQUES USED AT LASL FOR FABRICATION OF CUSTOM GASKETS. Pierre F. Hartshorne and James S. Church (Los Alamos Scientific Lab., N. Mex.). Aug. 21, 1962. Contract W-7405-eng-36. 38p.

A summary of techniques used for producing a diversity of especially designed seals is presented. Parts are made by a variety of processes, most of which have commercial parallels or duplicates. Sealing problems considered involve isolation of gases from gases, liquids from liquids, and gas systems from liquid systems. Static and kinetic sealing problems were encountered at pressure differentials from zero to ~3,000 psi, and operational temperatures have ranged from −20 to +300°C. Numerous chemical environments, many of them peculiar to LASL research projects, have complicated solution of sealing problems. A catalog of practical problems and solutions is included. General principles are given which are standard and in relative agreement with commercial practices. (auth)

16176 (NAA-SR-Memo-7955) WEIGHTS AND EFFICIENCIES OF HELICAL-ROTOR ELECTROMAGNETIC PUMPS FOR SODIUM SERVICE. Richard S. Baker (Atomics International, Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 12, 1962. Contract [AT (11-1)-Gen-8]. 11p.

In order to provide information regarding the weights, efficiencies, and dimensions of helical-rotor electromagnetic pumps designed for rated flows from 1000 gpm to 20,000 gpm (molten sodium), curves are presented giving magnitudes of these items. Calculations were made on the Rocketdyne computer, using the code "Program for Optimizing EM Pump Design." Pump designs were prepared for developed pressures of 50 psi and 100 psi; and for sodium temperatures of 600°F and 1200°F. (auth)

16177 (SC-4764(RR)) TURBULENT MIXING OF AXISYMMETRIC COMPRESSIBLE JETS (IN THE HALF-JET REGION) WITH QUIESCENT AIR. R. C. Maydew and J. F. Reed (Sandia Corp., Albuquerque, N. Mex. and Sandia

Corp. Livermore Lab., Livermore, Calif.). Mar. 1963. Contract [AT(29-1)-789]. 55p.

Velocity profiles at five axial stations in the half-jet mixing region of Mach 0.7, 0.85, 0.95, 1.49, and 1.96 free jets were measured. The nondimensional velocity distributions are similar, and correlate with the theory of Crane for incompressible flow. The half-jet spreading rate is essentially constant at subsonic speeds and decreases at supersonic speeds. The variation of jet spreading parameter with Mach number was determined from correlation of these and other data. (auth)

16178 (TID-17887) THE TRUE STRESS-STRAIN PROPERTIES OF BRITTLE MATERIALS TO VERY HIGH TEMPERATURES. Final Report, 1961–1962. (Southern Research Inst., Birmingham, Ala.). Oct. 27, 1962. Contract AT(40-1)-2694. 88p.

The stress-strain properties of several materials were determined at temperatures from room to 5000°F in order to evaluate the influence of some specimen variables on the mechanical properties of these materials. The materials investigated were two densities and two grain orientations of ZTA graphite, ATJ graphite, and 99.5% pure alumina. The notch effect on ATJ graphite was studied to determine the most practical configuration of tensile specimen. The results obtained for all materials are presented and discussed. (H.G.G.)

16179 (TID-18074) FEASIBILITY OF CREATING SPHERICAL CAVITIES IN UNDERGROUND SALT DOMES. Progress Report, December 1962–January 1963. (Texas. Univ., Austin). Contract AT(29-2)-1051. 35p.

A series of tests are described in which the material balance equation is utilized to relate the amount of salt dissolved to the amount of space occupied by the inert blanket material and brine. The general procedure in the technique is to wash the cavity for a time and calculate the incremental height. Three cavities were washed in series. They were all projected as 12 in. spheres, and were washed in Hockley salt with about 10% insoluble material. The inert material was kerosene with an oil soluble blue dye. Data and information concerning the cavity closure tests are included along with tabulated data obtained in the washing process. (J.R.D.)

16180 (TID-18233) REPORT ON GOODYEAR INFLATABLE SEAL TEST FOR E.G.C.R. CHARGE MACHINE BLISTER DRIVES. (EANCO Inc., Philadelphia and Associated Testing Labs., Inc., Wayne, N. J.). Nov. 7, 1962. 12p.

Four inflatable seals of fluorocarbon rubber were tested for use on the shafts of the various blister drives for the EGCR charge machine. Prior to and at the completion of the high temperature test, a pressure differential test was performed. The pressure differential prior to conducting the high temperature test was 100 psig. All of the inflatable seals leaked excessively at the completion of the high temperature test. Leakage was observed around the metal insert of each inflatable seal. Hence, the pressure differential could not be determined at the completion of the high temperature test. (H.G.G.)

16181 (TID-18283) ULTRAHIGH VACUUM TECHNIQUES. Annual Report, January 1–December 31, 1962. Research Report 63-828-441-R1. D. W. Feldman, R. E. Fox, O. M. Katz, W. J. Lange, G. J. Schulz, and J. H. Singleton (Westinghouse Electric Corp. Research Labs., Pittsburgh). Feb. 20, 1963. Contract AT(30-1)-2823. 45p.

Studies of basic phenomena associated with particle interaction at surfaces is described. Preliminary results of these studies are presented. The development of components and techniques, which are described, is a natural result of new technology necessary for the proper pursuit of the basic research programs and are reported because of the general interest by those working in ultrahigh vacuum research. Progress in vacuum techniques during 1962 is covered in this report. (H.G.G.)

16182 (TID-18292) THE APPLICATION OF GAS-LUBRICATED BEARINGS TO HIGH-SPEED TURBO-MACHINERY. Quarterly Technical Report, September 1, 1962–November 30, 1962. E. J. Gunter, J. G. Hinkle, and D. D. Fuller (Franklin Inst. Labs. for Research and Development, Philadelphia). Contract AT(30-1)-2512. 39p. (Q-A2392-3-7)

A program directed towards developing procedures for designing practical gas-lubricated bearings for use in high-speed turbo-machinery is discussed. Effort has been applied to the design and analysis of two separate bearing systems; one system requiring external pressurization, and the other being of a self-acting nature. A review of the theoretical and experimental work that has been performed on the self-acting, gas bearing rotor is presented. This rotor was tested at speeds up to 20,200 rpm. Film thickness measurements of the self-acting pivoted shoes were obtained for various pivot positions to ascertain the optimum pivot location. A secondary technique to measure film thickness indirectly was developed to permit the monitoring of two shoes simultaneously. In addition, a shaft attitude-eccentricity locus was obtained. Theoretical performance of pivoted-pad partial journal bearings is presented in the form of computer field maps for values of $\Lambda = 1.5, 2.5, 3.0, 3.5,$ and 4.0. Extended theoretical load-deflection curves for a shoe pivoted at $\phi/\alpha = {}^{2}/_{3}$, are presented. An analytical equation, which was derived from the computer data, is given to predict the load-carrying capacity of a pivoted-pad bearing. Performance characteristics of the pivoted-pad gas bearing are compared to the characteristics of a flat slider bearing using an incompressible lubricant. (auth)

16183 (NYO-9801) HIGH PRESSURE PUMP SEAL DEVELOPMENT. Engineering Quarterly Progress Report, December 1962–February 1963. R. C. Hajner (Worthington Corp. Advanced Products Div., Newark, N. J.). Mar. 8, 1963. Contract AT(30-1)-2682. 49p.

The principles underlying the operation of the high pressure seal and the concept of controlled leakage through the seal are presented. The importance of the bearing pods in the seal operation is discussed. Tests indicate that a Bearium B-11 stator material running against a Kennametal K-96 rotor give a positive seal. The range of minimum leakage flow through the high pressure seal at optimum performance was found to be 3.16 to 1.58 gph at 2000 psig which is equivalent to a film thickness range of 155 to 125×10^{-6}. A model seal test of 507 hours duration at 2000 psig and 2.75 gph leakage flow was conducted. Examination of the seal faces after this test showed no measurable wear within limits of optical inspection. (H.G.G.)

16184 (AERE-Trans-920) THE INFLUENCE OF SORPTION EFFECTS ON MEASUREMENTS MADE UNDER ULTRA-HIGH VACUUM. W. Pupp. Translated by E. G. Peters (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Vide, 17: 227-30(1962). 9p.

Considerations involved in making accurate quick measurements of the pumped volume and maximum vacuum of turbo-molecular pumps being acceptance-tested are examined. Sorption effects on the time required for

the tests and the feasibility of using Bayard-Alpert (B-A) gages are given particular attention. Sorption does not influence volume measurements if the pressures are permitted to settle; use of dry gas speeds up this equilibrium process. Sorption effects do mask the influence of leakage by introducing unknown amounts of gas into the pump. Results of tests made with an inserted B-A gage and a B-A gage in a glass tube are compared and reveal the glass tube arrangement to be usable in the absence of an inserted gage. To insure comparable accuracy, however, the glass tube must be kept thoroughly degassed. The length of time required for evacuation is reduced by heating the pump as early as possible. (D.C.W.)

16185 CONTINUOUS MEASUREMENT OF RADIOACTIVE FLUIDS WITH AN AUTOMATIC SUCTION DEVICE (FOR USE IN GAMMA MEASUREMENTS OF GEL-FILTRATION EXTRACTION). W. Stumpf, B. Steiner, and E. H. Graul (Philipps-Universität, Marburg, Ger.). Atompraxis, 9: 21-3(Jan. 1963). (In German)

A procedure for measuring radioactive liquids by means of electric level-control and automatic suction is described. Besides the measurement cell, the procedure requires a pump with relay control, a well-type measurement unit, and a line recorder (or a controlled counter with a pulse-time printer). It was used for separating radioactively labeled substances with a Sephadex column (gel filtration). The particular advantage of the method is that measurement accuracy does not depend upon a continuous inflow of liquid, as is the case with previous procedures, and also that small amounts of liquid can be measured. (auth)

16186 CHARACTERISTICS OF SPACE-CHARGE THERMOELECTRIC CONVERTERS CONPENSATED BY A CESIUM PLASMA. Jean-Edgar Picquendar, Eugène Dieulesaint, and Philippe Defranould. Compt. Rend., 256: 103-5(Jan. 2, 1963). (In French)

Two types of thermoelectric converters in which the space charge is compensated for by a natural plasma of cesium ions were developed. The heating of the cathode is obtained in the first model by electron bombardment and, in the second, by a luminous radiation falling on the cathode. A maximum yield of 14% with 115 amp under 0.72 v was obtained. (tr-auth)

16187 A NERNST EFFECT POWER GENERATOR. S. W. Angrist (Carnegie Inst. of Tech., Pittsburgh). J. Heat Transfer, 85: 41-8(Feb. 1963).

The direct conversion of heat to electricity by means of the Nernst effect is analyzed. The Nernst effect is the creation of an electrical potential perpendicular to both an applied temperature difference and an applied magnetic field. The effect is pronounced in semiconductors which have large mobility, large mobility ratio, and relatively small energy gap. Indium antimonide exhibits theoretically the best performance to date. A Nernst effect generator using indium antimonide experiencing an applied temperature difference of 300 deg K and a magnetic flux density of 10 kilogauss would have a thermal efficiency of about 1.6 percent and a power density of 10 watts per cubic centimeter. (auth)

16188 MHD POWER GENERATION BY NON-THERMAL IONIZATION AND ITS APPLICATION TO NUCLEAR ENERGY CONVERSION. E. J. Sternglass, T. C. Tsu, G. L. Griffith, and J. H. Wright (Westinghouse Electric Corp., Pittsburgh). Nucl. Energy, 60-6(Mar. 1963).

One of the most severe limitations of MHD power generation is the high temperatures required for thermal ionization. Two alternative, nonthermal ionization methods are considered: electron-beam injection and fission-product radiation. Electron-beam injection appears to be the most promising method. The thermodynamic cycle of a power plant incorporating a MHD generator and a reactor is considered. The design of a MHD generator with nonthermal ionization and the use of MHD compressors are discussed. (D.L.C.)

16189 FISSION-FRAGMENT CONVERSION REACTORS FOR SPACE. C. J. Heindl, W. F. Krieve, and R. V. Meghreblian (California Inst. of Tech., Pasadena). Nucleonics, 21: No. 4, 80-5(Apr. 1963).

A typical fission-electric cell is described, in which a very thin layer of fissionable material covers a cylindrical cathode and a second concentric cylinder acts as an anodic fission-fragment collector. Continued open-circuit operation of the cell should lead to a buildup potential of 4×10^6 volts. Among the problems to be solved is unwanted electron emission. The research program being carried out on the cell is described together with some experimental results; a voltage of 810 volts has been obtained. An analysis of the cell performance is given. In-pile experiments and high-voltage experiments now in progress are described. (D.L.C.)

16190 ENERGY FOR REMOTE AREAS. J. G. Morse (Martin Marietta Corp., Baltimore). Science, 139: 1175-80(Mar. 22, 1963).

Radioisotope-fueled generators are being used to supply power in small terrestrial and space systems. The fuel choice, energy conversion system, and effects of environment on the generator design are discussed. Various generators now in operation or under development are described. (D.L.C.)

16191 A SEVEN KILOWATT ELECTRON BOMBARDMENT FURNACE FOR GENERAL LABORATORY USE. T. Beirne (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Vide, 17: 592-603(Nov.-Dec. 1962). (AERE-R-3579). (In English, French)

Since electron bombardment results in the direct generation of heat in the specimen, this type of furnace can be more compact than other types. A description is given of an electron bombardment furnace designed for use in studies of dimensional changes of carbon and graphite on heating to high temperatures and of the graphitization process. (D.L.C.)

16192 SIMPLIFIED CALCULATION METHODS OF SHELL STRUCTURES. Proceedings of the Colloquium on Simplified Calculation Methods, Brussels, September 4-6, 1961. A. Paduart and R. Dutron, eds. Amsterdam, North-Holland Publishing Co., 1962. 538p.

Twenty-seven papers and four discussions are presented which treat methods for analysis and calculations in the mechanics of thin shells. The methods treated include general methods, methods for surfaces of alternate gaussian curvature, methods for surfaces of zero gaussian curvature, and simplified methods for instability problems. (D.L.C.)

16193 SNAP-7A, 7B, AND 7D (Engineering Materials). (Martin Co. Nuclear Div., Baltimore). 8 drawings. (CAPE-937)

These Systems for Nuclear Auxiliary Power use heat that is produced by the decay of Sr^{90} to generate electricity in thermoelectric converters. SNAP-7A and 7B are 5- and 30-w respectively, thermoelectric generators used by the U. S. Coast Guard in operating lighted marine aids to navigation. Converters and generators supply 10 and 60-w. SNAP-7C and 7D are also 5- and 30-w power supplies used by the U. S. Navy to provide power for unmanned, remote, automatic weather stations. The systems operate without moving parts. (F.L.S.)

16194 FOUR LITER DISSOLVER SOLUTION TO CASK. (Engineering Materials). (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). 3 drawings. (CAPE-858)

The cask is used to store and transfer radioactive solutions locally. Transfers of active solution from the cask may be accomplished by displacement with a light organic solvent if precise control of flow rate from cask to process equipment is required. The cask is 24 in. high and 26 in. in dia. The total weight is 3,000 lb. The 6 in. ID stainless steel inner container is 12 in. high. The lead filler between the 2 containers provides 6 in. of shielding. (F.L.S.)

16195 SPACE PROPULSION COMPONENT RESEARCH. Edward E. Stein. Preprint Paper No. 63-64. New York, Institute of the Aerospace Sciences, 1963. 22p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

A few Air Force applied research programs in the area of space propulsion were presented. Initial results indicated the development of propulsion systems capable of long term operation in the space environment may not be as difficult as previously estimated. Some advancements were described and a few of the trends of space propulsion research were identified. (C.E.S.)

16196 COMPARISON OF SOLAR-THERMAL AND SOLAR-ELECTRIC-THERMAL PROPULSION METHODS. Hans D. Linhardt (Aeronutronic, Newport Beach, Calif.). Preprint Paper No. 63-20. New York, Institute of the Aerospace Sciences, 1963. 37p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

The performance of solar-thermal and solar-electric-thermal propulsion systems was analyzed and compared on the basis of payload and transfer time when applied to satellite missions from 400-mile initial orbit to any high orbit, including escape. (C.E.S.)

16197 ROTATIONAL ENERGY LOSSES OF SMALL ROTORS IN THE ULTRACENTRIFUGE. Daniel Miller Spitzer, Jr. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 60p.

The nature and magnitude of the rotational damping experienced by a small, magnetically suspended sphere freely rotating in an evacuated glass chamber was investigated by evaluating its decay ratio (defined as the ratio of angular acceleration to angular speed). A system capable of measuring decay ratios as small as 10^{-10} sec^{-1} was constructed and used in the investigation. The nature of the damping was determined by measuring the decay ratio as a function of rotor speed and comparing the observed variation with that given by theoretical analysis of the effects due to several parameters. Rotor chamber pressures less than 10^{-9} torr, as evidenced both by independent ionization gauge measurements and by measured values of the decay ratio, were achieved by cryopumping with liquid helium. From the speed dependence of the decay ratio under ordinary operating conditions, the rotational damping was found to be essentially magnetic. The decay ratio had a magnitude on the order of 10^{-8} sec^{-1}. Attempts to decrease this residual rotational damping by decreasing the magnetic coupling between the rotor and the external lateral damping system led to decay ratios which were, in general, widely scattered, and occasionally as low as 2×10^{-10} sec^{-1}. The nature of the residual rotational damping was not determined because of the inherent lack of stability in this mode of operation. (Dissertation Abst., Vol. 23, No. 7)

16198 IMPROVEMENTS IN AND RELATING TO FEEDWATER TEMPERATURE CONTROL SYSTEMS OF TURBINE PLANTS. William Abraham Adolf Jacobus Jonker (to English Electric Co. Ltd.). British Patent 915,718. Jan. 16, 1963. Filed Sept. 16, 1958.

A feedwater temperature control system for a condensing steam turbine plant is described in which the feedwater temperature is automatically adjusted to any value desired for the actual load condition. This is accomplished by controlling the pressure in the feedwater de-aerator by means of live or bled steam. (C.E.S.)

16199 INTERLOCK SYSTEM. (to Chicago Bridge and Iron Co.). British Patent 915,939. Jan. 16, 1963. Priority date June 6, 1958, United States.

The interlock is designed in such a way that the inner door may be opened or closed from inside the containment vessel or from inside the airlock. The outer door may be opened or closed from inside the vessel, inside the airlock, or outside the vessel. The inner door is also operable from outside the vessel. (C.E.S.)

16200 MEDIUM TO HIGH VOLTAGE GENERATOR. Robert Jemison Van de Graaff and John George Trump (to High Voltage Engineering Corp.). British Patent 917,592. Feb. 6, 1963. Filed June 1, 1959.

A high-voltage d-c generator of the rotary dynamo-electric type is designed for maximum power output from a limited space. The generator comprises in series between two terminals a plurality of individual conducting members, each of which is followed by and connected in series with a rectifier connecting two adjacent members in series and rectifying the a-c output of its corresponding member. All d-c elements are connected in series to produce the d-c output of the generator. The conducting members are linked by a pulsating magnetic flux. (D.L.C.)

16201 IMPROVEMENTS IN AND RELATING TO COMPOSITE CLOSURE MEANS FOR A CONCENTRIC ARRANGEMENT OF DUCTS. Kenneth Basil Wallis (to General Electric Co.). British Patent 917,929. Feb. 13, 1963. Filed Dec. 7, 1959.

A composite closure means is designed for sealing off the inner and outer ducts of a concentric pair of ducts such as that used in reactors to convey hot fluid to a heat exchanger and to convey cool fluid therefrom. The closure means comprises two sealing means, one mounted in each duct and providing an annular seating, tubular closure members for engaging the seatings, and gas-operated piston means for sliding the closure members into engagement with the seatings. The sealing means may have neutron shields in order to shield the upstream and downstream from each other. (D.L.C.)

16202 CIRCUIT FOR STABILIZING THE CURRENT TO ALTERNATING-CURRENT ELECTROMAGNETS. British Patent 918,379. Feb. 13, 1963. Priority date, Sept. 30, 1959, Czechoslovakia.

A circuit is described for stabilizing the current to an a-c electromagnet with a nonlinear voltage-to-current characteristic, such as a betatron or synchrotron magnet. The circuit acts to reduce voltage fluctuations and is based on the series connection of a linear and a nonlinear impedance, where the magnet is the nonlinear impedance. Two embodiments of the circuit are shown. (D.L.C.)

16203 HIGH POWER KLYSTRON TUBE APPARATUS. (to Varian Associates). British Patent 918,586. Feb. 13, 1963. Priority date, Jan. 15, 1959, United States.

A klystron tube is designed with a novel component cooling system for long operation at high power levels (peak power, 2 to 5 Mw at 1700 to 5000 Mc). The tube comprises an electron collector, a r-f output window structure with a cavity resonator, a gun anode, cavity resonators, at least

one drift tube interconnecting the resonators, a tube connecting the output resonator with the electron collector, and means for cooling the tube components. (D.L.C.)

16204 FORCE MULTIPLIER HEAVY DUTY MANIPULATOR HANDLE. (to American Machine and Foundry Co.). British Patent 918,649. Feb. 13, 1963. Priority date, Apr. 1, 1960, United States.

A master-slave manipulator handle device is designed to multiply a gripping force. With this device, a cable can be tensioned in two stages, the first one being a lower stage. Means is provided for releasably locking the cable in any position. (D.L.C.)

16205 IMPROVEMENTS IN ELECTRICAL RESISTORS. Brian Walton (to Welwyn Electric Ltd.). British Patent 918,666. Feb. 13, 1963. Filed Apr. 20, 1960.

A high-voltage electrical resistor is designed for protection against the effects of very high voltage surges. The resistor comprises a cylindrical carrier member, a resistance winding or film on the outside of the carrier member, end caps mounted on the ends of the carrier member and electrically connected to the resistance winding or film, and a pair of electrodes extending into the interior of the carrier member to define a spark gap. (D.L.C.)

16206 DOUBLE SEALS EQUIPPED WITH MEANS FOR DETECTING LEAKS. (to Sulzer Freres Societe Anonyme). British Patent 918,894. Feb. 20, 1963. Priority date Feb. 4, 1960, Switzerland.

A double seal including means for detecting leaks is provided. One seal situated on the lower-pressure side is constructed as a sliding seal and the direction of slide is perpendicular to the sealing surface of the other seal. The space between the two seals is connected to a suction device comprising a trace detector. (C.E.S.)

16207 IMPROVEMENTS IN APPARATUS FOR MANIPULATING CAPSULES TO BE LOCATED IN AN IRRADIATION CHANNEL OF A NUCLEAR REACTOR. (to Commissariat a l'Energie Atomique). British Patent 919,356. Feb. 27, 1963. Priority date Aug. 30, 1958, France.

A manipulating apparatus is provided that is intended to be placed opposite an irradiation channel in order to load, unload, and transfer capsules. These operations are effected by remote control. (C.E.S.)

16208 IMPROVEMENTS IN OR RELATING TO FLUID CONTROL VALVES. (to Georges Francis Alexis Daumy). British Patent 919,956. Feb. 27, 1963. Priority date Dec. 23, 1960, France.

A fluid control valve is described that has its closure member in a fluid-tight chamber. The closure member is operated by the torsion of a spring inserted into a tubular coil. The spring is mounted to be freely movable inside the coil and is provided wholly or partly with one or more winding pitches different from the pitch of the coil. The torsion results from the lateral movement parallel to the common winding axis. (C.E.S.)

16209 CONCENTRIC TUBE STRUCTURE. (to Atomic Energy of Canada Ltd.). British Patent 921,281. Mar. 20, 1963. Priority date Feb. 9, 1961, United States.

A concentric pair of tubes is designed with spacing means between the tubes which permit relative axial movement of the tubes. The spacing means comprises an endless helical spring in contact with both tubes. The spring may be made of Zircaloy-2 or Inconel X for use as spacers between pressure tubes and calandria tubes in a nuclear reactor. (D.L.C.)

16210 IMPROVEMENTS IN OR RELATING TO COUNTING DEVICES. (to W. C. Heraeus Gesellschaft mit Beschränkter Haftung). British Patent 921,711. Mar. 20, 1963. Priority date, July 14, 1958, Germany.

A device is designed for counting bodies of electrically conductive material which are caused to move between gas-tight chambers. In this device, a coil is disposed about a gas-tight tube connecting the chambers, and the change of inductance of the coil due to passage of bodies through the tube is used to count the bodies. The device may be used in reactors using graphite bodies containing fuel. (D.L.C.)

16211 IMPROVEMENTS IN OR RELATING TO PLUGS FOR PIPES AND LOCKING MEANS THEREFOR. Terence Edward Gouvenot Gardiner, Robert Garbutt, and Philip William Davis (to Bristol Aerojet Ltd.). British Patent 921,770. Mar. 20, 1963. Filed Feb. 25, 1959.

A plug and locking means are designed for closing the ends of vertical standpipes in gas-cooled reactors. The plug comprises cap and closure parts, the closure part having a sealing surface for closing the pipe and the cap part being connected to the closure part by a bellows coupling. Hydraulic motor means is provided for using the pressure of the fluid in the pipe to lock the plug in place. (D.L.C.)

16212 PRESSURE VESSEL CONSTRUCTION. Jean Mercier. British Patent 921,775. Mar. 20, 1963. Filed Nov. 4, 1958.

A modified pressure vessel of the type described in British Patent 909,109, in which an internal bladder is provided, is designed. The vessel comprises a rigid container with an opening at one end, a bladder of resilient deformable material with a mouth at one end, a disc positioned inside the bladder amouth and having a diameter greater than that of the bladder mouth, and a hollow connection extending through the opening for providing communication between the bladder interior and the container exterior. The connection is shaped so that its outward movement presses the disc and bladder mouth against the container wall. A tight seal is obtained even if the inner wall of the container has irregularities. (D.L.C.)

16213 REMOTE-CONTROLLED MANIPULATING APPARATUS FOR MANIPULATING OBJECTS INSIDE SEALED CHAMBERS. Guy Chérel (to Commissariat à l'Énergie Atomique). Canadian Patent 650,606. Oct. 16, 1962. Priority date Nov. 16, 1957, France.

A remote controlled manipulating apparatus for sealed chambers is described, which does not call for the creation of openings in the walls of these chambers. A set of control units outside the chamber magnetically controls the group of operating units inside the chamber. (C.E.S.)

16214 NUCLEAR REACTOR DUCT CLOSURE DEVICE. Leon le Flem, Daniel Voeltzel, and Jacques Jouin (to Commissariat à l'Énergie Atomique). Canadian Patent 655,162. Jan. 1, 1963. Priority date May 5, 1959, France.

A device for closing a duct of a nuclear reactor is provided. The device is composed of two axially-aligned drums mounted for staggered rotation with respect to each other, each formed with axially directed ducts that are out of coincidence in normal position. In this way radiological protection by the full thickness of one drum is ensured in front of each duct. (C.E.S.)

16215 APPARATUS FOR PRODUCING AND MAINTAINING A DIFFERENCE IN PRESSURE BETWEEN INTERCONNECTED CHAMBERS CONTAINING GASEOUS MEDIA. Rudolf Scheffel, Gernot Zippe, and Max Steenbeck (to Deutsche Gold- und Silver-Scheideanstalt). Canadian

Patent 656,692. Jan. 29, 1963. Priority date Nov. 28, 1957, Germany.

A difference in pressure between interconnected chambers containing gases can be obtained by an apparatus consisting of at least one stator and at least one concentrically arranged rotor. The hollow rotor rotates at high circumferential velocity, gases therein being removed by pipes directed against the motion of the gas. (D.C.W.)

16216 MACHINE FOR DECANNING NUCLEAR REACTOR FUEL ELEMENTS. (to Commissariat à l'Énergie Atomique). French Patent 1,271,235. July 31, 1961. Filed July 29, 1960.

The machine for decanning fuel rods comprises two semi-cylindrical jaws between which the canned rod is fixed and which brings about a longitudinal bulging of the can, a cutting tool which slits open the bulge, and a pusher which extrudes the fuel rod from the slit can. (NPO)

16217 METHOD FOR PREPARING AN ENCASED KRYPTON-85 RADIATION SOURCE. Guenther Vormum and Hans-Juergen Muenster (to Deutsche Akademie der Wissenschaften, Berlin). German Patent DAS 1,142,040. Jan. 3, 1963. Filed Apr. 26, 1961.

A method is given for preparing encased krypton-85 radiation sources with the help of common laboratory means such as a normal vacuum-pumping equipment and an analytic balance. The method comprises the disposing of a certain weighted amount of krypton-clathrate within the capsule, evacuating the capsule afterwards, and sealing it. The sealed capsule is heated to perhaps 120°C by putting it into an oil bath. At 120°C, a temperature well above the disintegration temperature of the krypton-clathrate, the radioactive Kr^{85} is set free quantitatively. Another way to get a predetermined source strength is to dispose the krypton-clathrate in a separate space of the capsule which is connected to its main space through a narrow channel. A radiation measuring device is set up in front of the radiation transparent window, which is part of the confinement of the main space, and when the required strength is reached the channel is sealed and the heater removed. (Gmelin Institute)

16218 REACTIONAL VESSEL. Walter P. Haass (to Westinghouse Electric Corp.). U. S. Patent 3,075,909. Jan. 29, 1963. Filed Apr. 12, 1957.

The design of a reactional vessel was developed, in which the interior walls of the vessel and the thermal shields within the vessel are cooled by controlling the coolant flow between the walls and the shields. To increase the pressure drop across the flow passages between the walls and the shields, the passages are connected to the suction side of the coolant pump, thereby maintaining coolant flow through the passages. The design of the vessel and the associated cooling system is described in detail. (M.P.G.)

16219 BALL AND SOCKET JOINTS FOR REMOTE CONTROLS. René Leroy, Antoine Fortin, Jean Vertut, and Marcel Fortin (to Commissariat a l'Energie Atomique). U. S. Patent 3,082,045. Mar. 19, 1963. Priority date July 7, 1959, France.

A ball-and-socket joint is designed for passing controls into sealed walls. The joint comprises a sphere of radiation-absorbing material surrounded by two casing shells of a hard material, two ball races in the casing, a shank member transversing the sphere along its diameter, and four ball bearings. The sphere can be rotated, and the joint can be disconnected from the wall without dismantling the wall. (D.L.C.)

16220 PLASMA ARC TORCH. Yoshiaki Arata, Tadao Uno, and Takezo Nakamura (to Shin-Meiwa Kogyo Kabushiki Kaisha). U. S. Patent 3,082,314. Mar. 19, 1963. Priority date Apr. 20, 1959, Japan.

A plasma arc torch for cutting, welding, etc., is designed in which the erosion of electrodes is reduced, the plasma is stabilized, and the amount of consumed inert gas is reduced. Three embodiments of the torch are described. (D.L.C.)

16221 THERAPY UNIT. Harry E. Koerner and Everett W. Vaughn (to Westinghouse Electric Corp.). U. S. Patent 3,082,322. Mar. 19, 1963. Filed Nov. 28, 1958.

An improved radiation therapy unit is designed for turning the radiation beam around the patient or the patient around in the beam. Two embodiments of the unit are described. (D.L.C.)

Heat Transfer and Fluid Flow

16222 (BNL-6826) HEAT TRANSFER TO MERCURY FLOWING IN-LINE THROUGH A BUNDLE OF CIRCULAR RODS. M. W. Maresca and O. E. Dwyer (Brookhaven National Lab., Upton, N. Y.). Jan. 31, 1963. Contract [AT (30-2)-Gen-16]. 43p.

Experimental results for the case of in-line flow of mercury through an unbaffled bundle of circular rods were compared with theoretical predictions. The bundle consisted of 13 one-half-inch-diameter rods of the calrod type arranged in an equilateral triangular pattern, the pitch : diameter ratio being 1.750. Measurements were taken only on the central rod. Six different rods were tested. All rods in the bundle were electrically heated to provide equal and uniform heat fluxes throughout the bundle. The test rods had copper sheaths with fine thermocouples imbedded below the surface for measuring surface temperatures. Some rods were plated with a layer of nickel, followed by a very thin layer of copper, to provide "wetting" conditions, while others were chrome-plated to provide "non-wetting" conditions. The precision of the results is estimated to be within 2 to 3%. An interesting finding, consistent with earlier predictions, was that the Nusselt number, under fully-established turbulent-flow conditions, remained essentially constant until a Reynolds number of about 40,000 was reached. (auth)

16223 (GAMD-2117) A USE FOR RADIOISOTOPES IN ABLATION EXPERIMENTS. J. H. Tillotson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 6, 1961. Contract AF29(601)-2207. 26p.

Two methods for utilizing radioactive tracers in ablation studies are discussed. One involves distributing a beta or gamma emitter homogeneously through the sample and mapping the small activity before and after ablation with a small angle detector. Changes in the count rate would indicate ablation and material transport on the surface. The other technique utilizes concentric rings of different isotopes deposited across the sample surface. Mapping for tracer activities before and after ablation using a pulse height channel analyzer as detector would again yield total ablation, but would also allow quantitative measurements of material transport. Factors necessitating corrections to the measurements, measurement techniques, and suitable counters are also discussed. A list of suitable beta and gamma sources is included. (D.C.W.)

16224 (GAMD-2237) VISCOUS FLOW OF ABLATING GREASE FILMS. C. W. Mautz (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Apr. 17, 1961. Contract AF29(601)-2207. 13p.

The protective value of thin films of grease on targets in ablation studies is examined. Relations are derived for the thickness of the films as a function of time for the mo-

tion of a film under an assumed pressure profile and under an assumed aerodynamic drag. The results show that the rate of grease flow from these effects is negligible. For thick films, motion after the forces have been removed is shown to be quite large. Metal is noted to have far less resistance to ablation than a film of silicone vacuum grease, due to the low viscosity of molten metal relative to grease. (D.C.W.)

16225 (GAMD-2257) THE BEHAVIOR OF A THIN VISCOUS FILM UNDER MECHANICAL AND THERMAL FORCES. T. Teichmann (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 8, 1961. Contract AF29(601)-2207. 20p.

Equations are developed for the determination of the flow of a viscous, incompressible fluid over a flat plate under the influence of surface forces, including normal and tangential forces, and for dealing with spatial and temporal behavior on an equivalent basis. This work does not lead to substantially new results, but enables consideration of more general spatial and temporal variations and enlightens the nature of the underlying approximations and their range of valid application. The additional consideration of heat conduction and evaporation seems to offer a possible description of the experimental findings when combined with viscous flow. (H.G.G.)

16226 (LADC-5310) THE PULSE METHOD OF MEASURING THERMAL DIFFUSIVITY AT HIGH TEMPERATURES. Robert D. Cowan (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 5p.

A method of measuring the thermal diffusivity α of a thermally-insulated material, which involves exposing a thin slab of the material to a very short pulse of radiant energy, is discussed. Theoretical equations describing the finite heat loss for this method are included. (H.G.G.)

16227 (NAA-SR-Memo-7945) SPIRAL BOILER EVALUATION. Jerome G. Wendt (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 9, 1962. Contract [AT(11-1)-Gen-8]. 19p.

The results of the boiler optimization are as follows: Approximate boiler weight (filled with NaK and Hg under operating conditions), 102 lbs; tube length, 68 ft; tube ID, 0.587 in.; surface-to-volume ratio, 25 ft^{-1}. The results of the boiler evaluation indicate that the centrifugal force produced by the spiraling effect is only $\frac{1}{10}$ that produced by twisted strip turbulators. Published data indicate that twisted strips do not appreciably increase pressure drop for equivalent weight flow but do increase the heat transfer coefficient. In the spiral boiler, Hg droplets are forced to only 50% of the heat transfer area, while in the twisted strip boiler, Hg droplets are forced to the entire heat transfer area. Thus a boiler with a twisted metal strip turbulator would be superior to a spiral boiler for the SNAP 2 system. (auth)

16228 (NAA-SR-Memo-8064) EFFECT OF GAS CONTENT ON ONB POINT FOR SANTOWAX OM + 30 w/o HB. C. E. Pocock and A. F. Lillie (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 9, 1963. Contract [AT-11-1-GEN-8]. 13p.

The ONB (onset of nucleate boiling) point of Santowax OM + 30 wt % HB (high boilers) in forced convection was measured as a function of the dissolved nitrogen content at velocities of 5 and 30 ft/sec, pressures of 150 and 200 psig, and bulk temperatures of 650 and 700°F. The data were too meager to formulate a quantitative correlation, but there is a clear indication that increasing the dissolved gas content lowers the heat flux and the temperature driving force at the ONB point. (auth)

16229 (NP-12631) MEASUREMENTS OF SKIN FRICTION FOR TURBULENT MAGNETOFLUIDMECHANIC CHANNEL FLOW. E. C. Brouillette and P. S. Lykoudis (Purdue Univ., Lafayette, Ind. School of Aeronautical and Engineering Sciences). Aug. 1962. 33p. (A&ES-62-10)

Experiments were conducted in a range of fully developed turbulent flows of mercury in a rectangular duct in the presence of a transverse magnetic field. Friction coefficients expressing the effect of the magnetic field on the flow were derived, covering the Reynolds number range from 7.7×10^4 to 4.0×10^5 and the Hartmann number range from 0 to 73. Previously reported results up to a Reynolds number of 1.2×10^5 agree with the present values. At higher Reynolds numbers, the present data show a strong monotomic increase of the skin friction coefficient for a given Reynolds number and increasing magnetic fields in variance with the "minimum C_f" observed at lower Reynolds numbers. The present data, therefore, invalidate theoretical predictions based on such a minimum. (auth)

16230 (PWA-2132) EXPERIMENTAL INVESTIGATION OF HEAT REJECTION PROBLEMS IN NUCLEAR SPACE POWERPLANTS. Second Quarterly Report, September 1 through November 30, 1962. H. R. Kunz, H. L. Ornstein, S. S. Wyde, Sr., and J. R. Hooper, Sr. (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract NAS3-2335. 119p.

Progress on an experimental program to obtain data concerning: flow distribution and losses in header-tube configurations for space radiators, stability of header-condenser-tube combinations, and start-up and transient operating characteristics of a variety of simulated Rankine cycle space power plants utilizing single-phase and two-phase segmented radiator systems is discussed. Checkout of the manifold hydrodynamic loss facility was completed. Photographic and pressure loss tests were conducted on four plexiglass manifolds with single branch tubes. The condensing stability rig facility was checked out and preliminary pressure loss runs were conducted in a single tube. The initial direct-condensing Rankine loop was constructed, including the heat rejection system. Transient start tests were conducted under varied conditions. Data are presented on all of the runs performed. (H.G.G.)

16231 (TID-15719) LOW HEAT-FLUX BOILING. Second Quarterly Progress Report, October 1, 1961 to January 1, 1962. John A. Clark, Herman Merte, Jr., Edward R. Lady, Jaring Vander Veen, and Wen-Jei Yang (Michigan. Univ., Ann Arbor. Coll. of Engineering). Apr. 1962. Contract AT(38-1)-260. 38p. (ORA-04653-2-P)

This report covers progress made in the design of a system to study boiling of water from the outer surface of tubes at low values of heat flux (from 5,000 to 100,000 Btu/hr ft^2) and pressures up to 2,000 psia for both natural and forced convection. The primary and secondary electrical power systems are discussed. The various water piping systems (primary flow, purification, and pressure control loops) are described. The results of a literature survey are presented. The survey covers effects of heating surface, pressure, gravity, and vapor quality on nucleate-boiling heat transfer. It also discusses heat transfer in two-phase flow. (auth)

16232 (TID-16555) THE PROBLEM OF PNEUMATIC PRESSURE LAG. PART I. STEADY STATE FLOW IN A TUBING SYSTEM. Arnold L. Ducoffe and Frank M. White, Jr. (Georgia Inst. of Tech., Atlanta). July 1962. Contract [AT(29-1)-789]. 39p. (SCDC-2744)

An analytical and experimental investigation of the steady state isothermal flow in a series system, comprised of a constant-diameter tube with reduced size unions located at the tube extremities, is presented. The pressure drop across the system was determined experimentally as a function of the system geometry. The parameters chosen for investigation were the tube length to diameter ratio, L/D, the union diameter to tube diameter ratio, D_f/D, and the Reynolds number. The ranges of the parameters investigated consisted of $159 \leq L/D \leq 1475$, $0.7 \leq D_f/D \leq 1.0$, and $200 \leq$ Reynolds Number $\leq 100{,}000$. All tests were conducted at room temperature. The theory is derived considering each geometric element of the system, such as, inlet, development, length, exit, etc., and a set of five simultaneous algebraic flow equations results. Solutions to these were obtained by use of a digital computer. A pseudo friction factor for fully-developed laminar or turbulent flow is defined. The result indicates that the correlation of theory with experiment is quantitative over the range of parameters investigated. (auth)

16233 (TID-18141) COMPARISON OF TWO DIFFERENT ANALYTICAL MODELS WITH EXPERIMENTAL RESULTS IN AIR-WATER FLOW THROUGH THE VENT TUBE. Bimonthly Report No. 16, December 1, 1962–January 31, 1963. H. S. Isbin (Minnesota. Univ., Minneapolis). Contract AT(11-1)-926. 17p.

Two different analytical models, a linearized model and force balance model, were used to check the experimental data for an air-water flow system simulating certain features of a loss-of-coolant accident. The "dry well" pressure predicted by the linear model is higher than the measured value. The predicted displacement of the air-water interface versus time yielded good agreement with the measured value for a small vent tube (dia 0.875 in.), but not for the large one (dia 1.5 in.). The force balance model does not predict the dry well pressure and also fails to give satisfactory results for the large vent tube. (H.G.G.)

16234 (UCRL-10527) DOWNFLOW BOILING OF n-BUTANOL IN A UNIFORMLY HEATED TUBE (thesis). Graham F. Somerville (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 29, 1962. Contract W-7405-eng-48. 105p.

Local heat-transfer coefficients and two-phase total-pressure drops were measured for the forced-convection boiling of n-butanol in electrically heated tubes having an ID of 0.4670 in. and heated lengths of 5.69 and 4.10 ft respectively. Heat fluxes ranged from 2.8×10^4 to 6.6×10^4 Btu/h-ft^2 and mass fluxes from 136 to 440 lbm/sec ft^2. Exit qualities up to 31% were obtained at 16.9 to 50.0 psia. Measured heat-transfer coefficients ranged between 2,000 and 10,000 Btu/h-ft^2-°F. The boiling heat-transfer data were compared with previous correlations that had been based on the water-steam system. A new boiling heat-transfer correlation was derived having the form $St = 0.9005\ Re_l^{-0.288}\ X_{tt}^{0.292}\ Bo^{0.191}\ Pr_l^{-0.233}$; it was successful in correlating data for both water and n-butanol to within ±30%. Local two-phase total-pressure gradients which ranged up to 8 psi/ft, were successfully correlated by the method of Schrock and Grossman. Local two-phase frictional-pressure gradients were obtained and compared with previous results for water-steam systems. (auth)

16235 (WAPD-T-1566) VISUAL STUDY OF BOILING WATER AT HIGH PRESSURE. E. R. Hosler (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Jan. 1963. Contract AT(11-1)-Gen-14. 24p.

High speed motion pictures were taken of boiling water flow in a rectangular channel. The flow channel was 0.134 in. thick × 1.0 in. wide × 24 in. long heated on one side, the other three sides being used for observation of the boiling phenomena. The test section was so constructed that the images of the front view and both side views were visible from the front and photographed simultaneously. The three views provided much more information than the single views of previous photographic studies. Having both front and side views, each phase can be located accurately with respect to both space and time. Motion pictures at 4000 pictures per second permit determination of bubble and drop velocities, growth and collapse rates, wave velocities and other phenomena as a function of time. Still photographs with an exposure duration of 0.5 μsec arrest the motion and permit detailed examination of the two-phase mixture at a given instant of time. The motion pictures illustrate the various flow regimes that exist in the two-phase flow of water and steam in a small rectangular duct. The flow regimes which exist include bubble, separated annular, spray-annular, and wave flow. These flow regimes are described in terms of the local conditions of pressure, flow rate, heat flux and quality. The cameras were located on a movable platform which permitted axial scanning of the test section for determining the point of inception of bubbles and studying the flow regimes at various axial locations. (auth)

16236 (AERE-Trans-911(Pts. 1 & 2)) PART 1. THE EFFECT OF THE TEMPERATURE FACTOR ON HEAT TRANSFER IN THE TURBULENT FLOW OF A GAS IN PIPES. N. I. Ivashchenko. PART 2. SOME PROBLEMS OF HEAT EXCHANGE AND FRICTIONAL RESISTANCE IN TURBULENT FLOWS. S. S. Kutateladze. Translated by J. J. Cornish (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Teploenerg., No. 2, 72-5(1958); Ibid. No. 7, 40-5(1956). 15p.

I. A study of the effect of the temperature factor on heat exchange with a turbulent air flow in a pipe was undertaken. Experimental and theoretical determinations of velocity profiles and local heat transfer coefficients were made and compared. Calculation formulas that take into account the effects of the temperature factor on heat transfer are suggested. II. Heat transfer agents are classified according to the ratios of their velocities of molecular heat transfer to momentum, and equations are derived for the averaged turbulent flow of a compressible fluid. The influence exerted by density fluctuations on the intensity of turbulent transfer in a plane gas flow is evaluated, and the velocity in the core of a plane turbulent flow of compressible gas is shown to be a function of the sine of the logarithm of the distance from the wall. Gas flow in a pipe and flow around a plate are examined. (auth)

16237 (EURAEC-523) INVESTIGATION OF THE CRITICAL BOILING WATER BURNOUT. Quarterly Report No. 5, October 1–December 31, 1962. (Maschinenfabrik Augsburg-Nürnberg A. G., Nuremberg). Jan. 7, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 057-61-RDD. 11p. A translation.

Preparatory work for carrying out an investigation on the critical boiling water burnout in a high pressure pilot plant was pursued. The construction of the individual assemblies and conduits of the pilot plant was continued in the workshop. Testing of the three-wire thermocouple on a heated tube and investigation of the flow on the inlet side of the test section by means of an air/water mixture were carried out. Programs for calculating the thermodynamic properties of water and steam at pressures beyond 170 atm

and temperatures above 350°C on a digital computer were developed. Calculations were made of the temperature distribution in the heated wall of test models. The critical analysis of available experimental results was continued. (auth)

16238 BURNOUT CONDITIONS FOR FLOW OF BOILING WATER IN VERTICAL ROD CLUSTERS. Kurt M. Becker (Aktiebolaget Atomenerg, Studsvik, Sweden). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 9: 216-22(Mar. 1963). (AE-74)

A new concept is described for predicting burnout conditions for forced convection of boiling water in fuel elements of nuclear boiling reactors. The concept states the importance of considering the ratio of heated channel perimeter to total channel perimeter. The perimeter ratio concept was arrived at from an experimental study of burnout conditions in rod clusters consisting of three rods of 13 mm outside diameter and 830 mm heated length. Data were obtained for pressures between 2.5 and 10 kg/cm^2, surface heat fluxes between 50 and 120 w/cm^2, mass flow rates between 0.03 and 0.33 kg/sec, and steam qualities between 0.01 and 0.52. The rod clearances for the experiment were 2 and 6 mm. The diameter of the channel was 41.3 mm. Additional runs were also performed after unheated displacement rods were introduced in the channel. The rod clearance in this case was 6 mm. In the ranges investigated the measured burnout steam qualities at the outlet of the channel decrease with increasing heat flux and decreasing pressure. Furthermore, it was found that the influence of rod clearance is, in the range investigated, of small significance for engineering purposes. It was also observed that the present burnout steam quality data for the rod clusters are much lower than those earlier obtained for round ducts. This may be explained physically by means of the perimeter ratio concept. It was also found that the surface shear stress distribution around the channel perimeter and especially the position of maximum shear stress is of great importance for predicting burnout conditions for flow in channels. Finally the new method has helped in understanding and interpreting experimental results which earlier may have seemed inconsistent. (auth)

16239 TWO-PHASE CRITICAL FLOW OF STEAM-WATER MIXTURES. Duane W. Faletti and R. W. Moulton (Univ. of Washington, Seattle). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 9: 247-53(Mar. 1963).

Critical flow of two-phase steam-water mixtures in annuli was studied, with a cylindrical test section 0.574 in. in diameter with an axially centered rod, 0.187 or 0.375 in. OD, as a pressure probe. Pressure taps on the wall and the center rod permitted an accurate determination of the pressure profile over the entire length of the section, and, in cases where a movable probe was used, a short distance into the downstream exhaust chamber. Results were correlated by plotting the ratio of the observed critical mass velocity to the theoretical critical mass velocity for homogeneous flow as a function of quality. Exit pressures were found to be lower than most values previously reported. The ratio G_0/G_{TH} was found to be independent of the probe diameter, the manner of upstream steam-water mixing, and, for test sections greater than 9 in. in length, the test section length. Since probe diameter had no observable effect on G_0/G_{TH}, the correlation may be applicable to full bore pipes near ½ in. in diameter. In the range of qualities from 2 to 15% the critical G_0/G_{TH} ratio was depressed with increasing exit (throat) pressure, but at other qualities no pressure dependency was noted. The effect of changing the downstream exhaust chamber pressure was found to influence the exit pressure but to have little effect on the observed critical mass velocity. Addition of surface active agents to the steam-water mixture did not affect the mass velocity but did result in increased exit pressure. (auth)

16240 A STUDY OF CARRY-UNDER PHENOMENA IN VAPOR LIQUID SEPARATION. Michael Petrick (Argonne National Lab., Ill.). A.I.Ch.E. (Am. Inst. Chem. Engrs.) J., 9: 253-60(Mar. 1963).

Vapor-liquid separation by gravity becomes more difficult when the system volumetric capacity decreases and power density increases. An analytical and experimental study of the carry-under problem (vapor entrained in the downcomer) was conducted on the effects of parameters on the amount of carry-under. Experiments were carried out on an atmospheric air-water loop and a high-pressure steam-water loop. A nondimensional correlation was derived for both air-water and steam-water data. (D.L.C.)

16241 A HYDRODYNAMIC MODEL OF MASS TRANSFER IN A STIRRED VESSEL EXTRACTOR. D. R. Olander (Univ. of California, Berkeley). Chem. Eng. Sci., 18: 123-32(Feb. 1963). (In English)

The flow patterns generated by the rotation of stirrer bars in the two immiscible liquids in a stirred vessel extractor were approximated by a simplified model. Each phase was divided into two regions: the core region, which is the cylindrical volume swept out by the stirrer bars, and the outer annular region, which comprises the remainder of the phase. The flow in the core region was assumed to be equivalent to that generated by an infinite body of fluid in solid body rotation over a surface rotating at a slower rate. The axial velocity in the outer annulus is then obtained by a simple material balance. Knowledge of the velocity profile in this latter region permitted a direct solution of the diffusion equation, which in turn resulted in a purely theoretical mass-transfer correlation for this extraction device. Comparison of the experimental data and the theoretical predictions showed the latter to be approximately 35 to 50 per cent too low; this agreement was considered sufficiently close to warrant tentative acceptance of the flow model upon which the theoretical predictions were based. Two important conclusions which follow from the model are: (1) a turbulent transport mechanism need not be postulated for extraction in a stirred vessel of the type considered here, since a purely laminar flow model comes quite close to reproducing the observed extraction rates; and (2) rippling of the interface does not result in pronounced increases in the mass-transfer coefficient, since the flow model was based upon a planar interface, and the experimental data represent various degrees of interfacial rippling. (auth)

16242 HEAT TRANSFER AND SKIN FRICTION FOR TURBULENT BOUNDARY-LAYER FLOW LONGITUDINAL TO A CIRCULAR CYLINDER. E. M. Sparrow, E. R. G. Eckert, and W. J. Minkowycz (Univ. of Minnesota, Minneapolis). J. Appl. Mech., 30: 37-43(Mar. 1963).

An analysis was carried out for the turbulent velocity and thermal boundary layers that develop along a cylinder whose axis is parallel to the free-stream flow. Local and average friction factors are calculated as functions of the length Reynolds number Re_x for various cylinder sizes (characterized by the radius Reynolds number Re_{r_0}). For corresponding flow conditions, the friction factor for a cylinder always exceeds that for the flat plate. Local heat-transfer coefficients corresponding to the case of uniform wall heat flux were obtained for Prandtl numbers of 0.7 and 5. As with the friction factors, the cylinder heat-transfer coefficients exceed those for the flat plate. This effect of

the cylindrical geometry on heat transfer diminishes with increasing Prandtl number. (auth)

16243 OBSERVATION OF CAVITATION SCALE AND THERMODYNAMIC EFFECTS IN STATIONARY AND ROTATING COMPONENTS. Frederick G. Hammitt (Univ. of Michigan, Ann Arbor). J. Basic Eng., 85: 1-16(Mar. 1963).

Experimental measurements are presented on cavitation performance effects for a venturi test section and a centrifugal pump. Theoretical expectations and comparisons with previous investigators' data are discussed. The following general conclusions are drawn: (1) Significant scale effects were found for all degrees of cavitation, and for both venturi and pump. The direction of the effects is consistent with present literature. (2) Certain of these effects can be correlated in terms of Reynolds' number; however, Reynolds' number alone is not a sufficient correlating parameter. (auth)

16244 VISUAL CAVITATION STUDIES OF MIXED FLOW PUMP IMPELLERS. G. M. Wood (United Aircraft Corp., Middletown, Conn.). J. Basic Eng., 85: 17-28(Mar. 1963).

Three mixed flow impellers representing a wide range of design parameters were tested in a closed water loop to obtain correlations of the high-speed photographic records of the cavitation formations with various performance parameters. It was found that cavitation existed for all impellers at much higher values of net positive suction head than those associated with a finite drop in the impeller head rise. The cavitation formations in the vane channels of the impellers were observed to be cyclic in nature, whereas the cavitation near the leading edge of the vanes was more stable. (auth)

16245 TRANSIENT NATURAL CONVECTION FROM VERTICAL ELEMENTS—APPRECIABLE THERMAL CAPACITY. B. Gebhart (Cornell Univ., Ithaca, N. Y.). J. Heat Transfer, 85: 10-14(Feb. 1963).

Natural convection transients are considered for laminar boundary-layer flow on vertical surfaces by the method previously presented. Cases are solved for elements having finite thermal capacity as, e.g., electric heaters or reactor elements. A wide range of thermal capacity is considered for fluid Prandtl numbers in the range 0.01 to 1000, for a step in internal energy generation rate. The Prandtl number effect is shown to be very small, in the generalized variables employed, and the range of thermal capacity which results in true convection transients is clearly delineated. (auth)

16246 MEASUREMENTS OF TRANSIENT NATURAL CONVECTION ON FLAT VERTICAL SURFACES. B. Gebhart and D. E. Adams (Cornell Univ., Ithaca, N. Y.). J. Heat Transfer, 85: 25-8(Feb. 1963).

Experimental measurements of natural convection transients in air and in water are compared with the results of integral analysis. An application of infrared techniques to the measurement of transient surface temperatures is described. The measurements, over a wide range of thermal capacity, are reduced to the variables which arose in the analysis and the measured responses are in essentially complete agreement with the results of that analysis for the case of a step in input flux. None of the measurements of natural convection transients on vertical plates has indicated temperature overshoot for the step condition. (auth)

16247 SEVERAL MAGNETOHYDRODYNAMIC FREE-CONVECTION SOLUTIONS. K. R. Cramer (Wright-Patterson Air Force Base, Ohio). J. Heat Transfer, 85: 35-40(Feb. 1963).

The influence of transverse magnetic fields on the laminar free-convection flow of liquid metals over a vertical flat plate and between vertical parallel plates is examined for specific wall temperature variations and Prandtl numbers. The extent of influence on the flow and temperature fields is determined by the magnitude of a nondimensional influence parameter which is the ratio of the magnetic force to the buoyant force. In general, increasing the magnetic field strength decreases the magnitude of the velocity, wall shear, and surfaces heat transfer and increases the temperature throughout the fluid. Analytical results demonstrate that magnetic fields of practical strengths exert considerable influence on liquid metal free-convection flow fields. (auth)

16248 DETERMINATION OF THE THERMAL CONDUCTIVITY OF BERYLLIA ROD BY MEASURING AXIAL TEMPERATURE DISTRIBUTION. Maksymilian Burk. Mater. Res. Std., 3: 25-8(Jan. 1963).

The determination of thermal conductivity using the equilibrium temperature distribution was investigated on a sintered beryllia rod. The rod was heated at one end and the heat allowed to dissipate from its side surface into a constant-temperature environment. The investigation was conducted from about –200 to 150°C. With this method a single series of measurements can supply the full temperature-dependence curve in the temperature interval between the environment and the heater temperature. The values of the heat transfer coefficient appeared unnecessary for calculating the thermal conductivity. The accuracy of the measurements was, however, limited to about ±10% due to the difficulty in determining exactly the amount of heat dissipated and the strong temperature-dependence of the thermal conductivity of beryllia. (auth)

16249 HEAT TRANSFER IN GRANULAR MEDIA. A STUDY OF FIXED AND FLUIDISED BEDS. Gerard Donnadieu (Centre National de la Recherche Scientifique, Paris). Rev. Inst. Franc. Petrole Ann. Combust. Liquides, 16: 952-77(Sept. 1961). (In French)

A study is made of the heat transfer occurring in a fluidized bed according to the two mechanisms of: 1) Heat transfer between fluid and solid grain. This takes place at the surface of solid grains; it is a convection mechanism. 2) Heat transfer resulting from the agitation of the solid grains in the bed; it is a kind of macro-conduction which is called "kinetic conduction". After briefly recalling the general properties of fluidized beds, a theory is developed on heat transfer in these beds. The experimental equipment and the measurement methods used and results obtained are described. The intensity of the heat transfer generated in the two mechanisms mentioned above is studied in relation to fluid flow rate, grain size of solid grains, and bed porosity. (auth)

16250 THE DYNAMICS OF A THERMALLY RADIATING GAS IN A RAREFIED ATMOSPHERE. L. Trilling (Massachusetts Inst. of Tech., Cambridge). Preprint Paper No. 63-54. New York, Institute of the Aerospace Sciences, 1963. 38p. $1.00.

Paper from 31st Annual Meeting, New York, 1963.

Self-similar unsteady solutions of the equations of motion for a plane layer of thermally radiating gas in a low density atmosphere were investigated. Many restrictive assumptions were made so that the results obtained had a somewhat qualitative character. The main result obtained was the role played by the ratio of specific heats in governing the assignment of energy to the several modes of release. (C.E.S.)

16251 THEORY OF STAGNATION POINT HEAT TRANSFER IN A PARTIALLY IONIZED DIATOMIC GAS.

James A. Fay and Nelson H. Kemp (Avco-Everett Research Lab., Everett, Mass.). Preprint Paper No. 63-60. New York, Institute of the Aerospace Sciences, 1963. 53p. $1.00.

Stagnation-point heat transfer in a partially ionized diatomic gas is considered. The concept of frozen thermal conductivity is used, and a simplified binary diffusion model of the gas is proposed. In this model the charge-exchange cross-section for atom-ion collisions is taken to be infinite so there is no relative diffusion of the atoms and the ion-electron pairs. This permits the diffusion effects to be dealt with as if there were only two components, molecules and atom-ion-electron particles, and thus greatly simplifies the calculations. However, the thermodynamic and transport properties are evaluated using all four components, molecules, atoms, ions, and electrons. With this model, calculations are made for both frozen and equilibrium boundary layers in nitrogen up to about 60,000 ft/sec, and arguments are presented for applying the results to air. The results show the equilibrium heat transfer rate to be progressively smaller than the frozen rate as the velocity increases above 30,000 ft/sec, the ratio reaching 2/3 at 50,000 ft/sec. Comparison with shock tube experiments, including the recent ones of Rose and Stankevics, shows that the equilibrium calculations are in general agreement with experiments. (auth)

16252 STAGNATION POINT HEAT TRANSFER MEASUREMENTS IN PARTIALLY IONIZED AIR. P. H. Rose and J. O. Stankevics (Avco-Everett Research Lab., Everett, Mass.). Preprint Paper No. 63-61. New York, Institute of the Aerospace Sciences, 1963. 37p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Experimental measurements of convective stagnation point heat transfer in partially ionized air at simulated flight velocities up to 50,000 ft/sec are presented. Stagnation point heat transfer rates were measured in an arc-driven shock tube. The operation of this tube was carefully monitored by a variety of diagnostic techniques, mostly using emitted radiation as the observable. Although the performance of an arc-driven shock tube was found to be quite predictable, it is shown that proper auxiliary measurements must be made for each experiment to identify those regions where proper flow conditions exist. Calorimetric heat transfer gages, either coated with silicon-monoxide films or uncoated, were used to measure heat transfer. The effects of boundary layer chemistry, radiation from the hot inviscid flow, and instrumentation errors are discussed. Comparison is made of the measured heat transfer rates with other data and the points of agreement and disagreement are analyzed. The data are compared to theoretical predictions made with a simple binary diffusion model of partially ionized diatomic gas, namely, nitrogen, whose transport properties were estimated from measured and calculated cross section data. Stagnation point heat transfer rates calculated from this model for both a frozen and an equilibrium boundary layer, as well as equilibrium boundary layer results from other available calculations using more elaborate models of air, are compared to the data. The applicability of frozen and equilibrium calculations are discussed. Although it is not possible to differentiate between a number of the very similar theoretical treatments of this problem from the present results, it is concluded that the transport properties of air up to 15,000°K are known to reasonable accuracy and that heat conduction by electrons does not present a serious engineering problem for flight velocities up to 50,000 ft/sec. (auth)

16253 FLOW MEASUREMENT IN CLOSED CONDUITS. Proceedings of a Symposium held at the National Engineering Laboratory, 27th-30th September, 1960. Volumes One and Two. Sessions A-G. Edinburgh, Her Majesty's Stationery Office, 1962. 773p. £4 4s.

Papers were given concerning: current meter methods of flow measurement in closed circuits; developments and merits of flow metering by orifice plates; studies of classical venturimeters and factors affecting their performance; flow tubes and nonstandard devices for flow measurement; salt-dilution and salt-velocity methods for accurate measurement of turbulent flow; the use of the Gibson method of flow measurement in Norway; and special methods of flow measurement, such as mass flowmeter, ultrasonic flowmeter, turbine-type gas flowmeter, and magnetic flowmeter. Twenty-nine papers were presented, all in English. (H.G.G.)

16254 IMPROVEMENTS IN AND RELATING TO FLUID FLOW INDICATORS. Peter Raymond Gledhill and James Lewis Ayre (to General Electric Co. Ltd. and Simon-Carves Ltd.). British Patent 917,198. Jan. 30, 1963. Filed Mar. 17, 1960.

A device is designed for indicating the rate of fluid flow in a duct without appreciable projection of the device into the stream. The device comprises a heat-conducting body adapted to be mounted in an aperture in the wall of the duct, a flat heat transfer surface in the body positioned to lie flush with the duct wall, means for heating the body, and means for indicating temperature changes of the heat transfer surface. The device is especially suited for use in fuel handling gear during refueling operations in heterogeneous reactors. (D.L.C.)

16255 IMPROVEMENTS IN AND RELATING TO HEAT EXCHANGERS AND STEAM GENERATORS. James Brewis Woodeson (to Clarke, Chapman and Co. Ltd.). British Patent 919,331. Feb. 20, 1963. Filed Mar. 17, 1958.

A heat exchanger for the generation of steam is provided. The heat exchanger is composed of a plurality of parallel-flow sheath ducts that contain helical tube coils disposed axially therein. The ends of the coils extend radially through the walls of the duct. This system has the advantage that the tube coils at least partially fill the space within the coil, limiting the cross-sectional area of the gas passage and promoting the efficiency of heat exchange through the wall of the coil. (C.E.S.)

16256 HEAT EXCHANGERS. (to Sulzer Freres, Societe Anonyme). British Patent 919,514. Feb. 27, 1963. Priority date Dec. 30, 1960, Switzerland.

A heat exchanger is described having two groups of tubes. Each group has an identical number of helically wound tubes of the same pitch, the tubes of longer length connected in series with tubes of smaller length in another tube group so that the lengths of the tubes through which the working medium flows are all equal. (C.E.S.)

16257 IONIZATION-TYPE HEAT EXCHANGE PROCESS AND SYSTEM. Louis Bochirol, Paul Perroud, Jacques Verdier, and Louis Weil (to Commissariat à l'Énergie Atomique). Canadian Patent 649,299. Sept. 25, 1962. Priority date Dec. 11, 1958, France.

A process for aiding heat exchange between a gas and a surface is described. The gas is ionized by an alternating electric field, by irradiation, or by thermionic emission. An electric field puts the ions in motion and maintains a dielectric barrier whereby arcing is prevented and recombination of ions is reduced. Glass, silica, ceramic ma-

terial, resin, and polytetrafluoroethylene may be used as insulators. (C.E.S.)

16258 LIGHT BOILER FOR NUCLEAR ENERGY INSTALLATION. André Huet. Canadian Patent 650,712. Oct. 23, 1962. Filed May 11, 1959.

An arrangement of concentrically disposed fluid circuits is made up of spirally wound tubes of different shapes, constituting a forced circulation boiler in which the economizer and evaporator sections are constituted in a similar manner. (C.E.S.)

16259 METHOD FOR RAISING STEAM BY TRANSPORTING THE HEAT DEVELOPED IN A NUCLEAR REACTOR TO A BOILER WITH THE HELP OF A SUITABLE HEAT TRANSFER MEDIUM. Johannes Hegemann (to Durrwerke Aktienges). German Patent DAS 1,142,367. Jan. 17, 1963. Filed Aug. 26, 1957.

In nuclear reactors with a closed primary loop in which a fluid is used to transport the heat developed in the reactor to a boiler in which steam is raised by evaporating a working fluid in a secondary loop and subsequently used to drive a turbogenerator set, it is desirable that the inlet temperature of the heat transfer medium at the inlet of the reactor remains constant, independent of the load. For economic reasons it is further necessary that the temperature of the working fluid at the outlet of the boiler as well as at the inlet of the turbine has a constant value. According to the method described this can be achieved by controlling the flow of the working fluid through the heat exchanging elements located within the boiler, e.g., by simultaneously regulating the entire inlet flow of the working fluid into the boiler and splitting up the inlet flow in such a way that part of the heat exchanging elements is either entirely or partly shut off from the fluid flow. (Gmelin Institute)

Materials Testing

Refer also to abstract 17427.

16260 (HE-150-210) TRANSIENT STRESS DISTRIBUTION IN A RAPIDLY HEATED ROD. A. L. Austin (California. Univ., Berkeley. Inst. of Engineering Research). Feb. 14, 1963. For Univ. of California Lawrence Radiation Lab., Livermore. Contract UCX-2285. 130p. (UCRL-13065)

An analytical and experimental investigation of the inertial stresses resulting from very high internal heat generation rates is described. The results show that the amplitude of the thermally induced elastic vibrations in an unrestrained thin rod are dependent upon the ratio of heating time to the fundamental period of oscillation, and that the most severe stress amplitude results from a constant heating rate as compared to an exponential type of input. In the experimental investigation, rapid heating was accomplished by the discharge of a low-inductance capacitor bank (0.1 uh, 2800 Joules) through the rod. A modified birefringent-coating method was used for observation of the thermally induced oscillations. Utilizing the frozen stress technique of three-dimensional photoelasticity, an initial pattern of interference fringes was introduced into thin strips of birefringent material which were securely bonded to each side of the rod. Strain oscillations were measured by direct observation of the movement of the fringe pattern with a high intensity incident light source, a crossed-circular polariscope, and a high speed framing camera. Interpretation of these measurements required a dynamic calibration and a correction factor for the reinforcing effect of the coating. Oscillations with periods from 35 to 250 μsec and amplitudes of 9000 psi were measured. The results were in good agreement with the uncoupled thermoelastic theory, and it is concluded that this technique is suitable for transient measurements in the presence of large magnetic fields which normally restrict the use of electronic methods. (auth)

16261 METHOD AND MEANS FOR ASSAYING FUEL ELEMENTS WHICH WERE MANUFACTURED BY SERIES. Heinz Stehle and Heinz Seguin (to Siemens-Schuckertwerke A. G.). German Patent DAS 1,141,733. Dec. 27, 1962. Filed Mar. 25, 1960.

A method is given for assaying new fuel elements which were manufactured by series for contamination on its surface and for defects in its cladding, before they are loaded into the reactor core. The method comprises the loading of the fuel elements into a test channel located in the same reactor in which they are to be burned, the test channel being part of a separate test loop, measuring the radioactivity of the coolant in the test loop before and after the insertion of the fuel element, and comparing these two values of activity. It is proposed to enclose in the can of the fuel element a solid material which can be easily activated and whose vapor pressure is rather high at the prevailing temperatures in the loop. The test channel is preferably located in the region between the core and the neutron shielding. Means for varying the pressure in the test loop are provided. (Gmelin Institute)

GEOLOGY, MINERALOGY, AND METEOROLOGY

Refer also to abstracts 15554 and 16874.

16262 (AD-297344) STOAT. Long Range Seismic Measurements of VELA UNIFORM Project 8.4. (Air Force Technical Applications Center, Washington, D. C.). Jan. 9, 1962. 30p.

Long range seismic measurements for the analysis of an underground nuclear test, STOAT, are presented. As a measure of the effectiveness of a network of hypothetical control stations having ~1000 km spacing, a comparison is made between the actual location of the shot and its computed hypocenter as determined by a digital computer. Best-fit values of latitude, longitude, depth of focus, and time of origin are determined statistically by a least squares method. Short-period signals from the STOAT event were recorded on film by 22 stations. Included are the P_n and P arrival times, the maximum amplitudes, and the travel time residuals from the P_n and P phase. Useful signals from STOAT were recorded to a distance of 1313 km. Following STOAT by ~27 minutes, a collapse event was recorded with measurable signals at 16 stations to a distance of 1005 km. (H.G.G.)

16263 (CEA-2035) THEORIE D'UNE METROLOGIE DU CHAMP MAGNETIQUE TERRESTRE BASEE SUR LA RESONANCE DE NOYAUX ATOMIQUES POLARISES. (Theory of a Metrology for the Earth's Magnetic Field Based on the Resonance of Polarized Atomic Nuclei). Georges Bonnet (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1962. 170p.

Thesis submitted to Universitć, Grenoble, France.

The problems presented by the metrology of the earth's field are studied from two points of view. The first, purely physical, concerns the study of NMR transducers in their role for the transformation of the magnetic field into a frequency. The possibilities and limitations are outlined. The use of an equivalent model is introduced systematically in the considerations of NMR phenomena; this makes it possible to treat all problems of interaction between a spin system and an electric detection system in a unified form. The other point of view concerns the restitution of the nuclear signal frequency in the form of a directly perceptible observable. The treatment of information is considered from a statistical angle, which leads to the study of an optimization process concerning the linearization of the measurement as well as the minimization of noise effects. 85 references. (auth)

16264 (ORO-199) SUPPLEMENTARY METEOROLOGICAL DATA FOR OAK RIDGE. William F. Hilsmeier (Weather Bureau, Oak Ridge, Tenn.). 57p.

Meteorological data involving weather parameters over a ten-year period (1949 to 1958) that influence construction, cooling and air conditioning designs, and other activities and interests in the Oak Ridge area are presented. Precipitation occurs in the Oak Ridge area on the average of one out of three days. Winds are predominantly NE and SW of light velocity. Temperatures are generally moderate, the mean temperature for the year being 58.5°F. Mean temperatures for the cold months of December and January are 40.1 and 39.9°F, respectively. The mean temperature for the warmest month, July, is 77.7°F. (H.G.G.)

16265 (PNE-111F) INTERMEDIATE RANGE EARTH MOTION MEASUREMENTS. L. M. Swift (Stanford Research Inst., Menlo Park, Calif.). Oct. 31, 1962. Project GNOME. 82p.

Data were obtained on the Gnome shot (3.1 ± 0.5 kt: detonated at a depth of 366 meters in Salado halite, near Carlsbad, New Mexico) to improve the capability of extrapolation and prediction criteria for earth motion at long ranges from underground shots, primarily to permit evaluation of damage capability to surface and subsurface offsite structures. Acceleration measurements were made at the surface and at shot depth at four ranges from 800 to 9500 meters. Surface measurements of particle velocity were made at 402 and 805 meters using three-component velocity gages, and at five stations from 8380 to 9357 meters using seismometers. Pressure measurements were made in the fluid in four annuli of the Shell James Ranch No. 1 well, about 9.5 km from surface zero. Where feasible, acceleration and velocity data were integrated to show velocity and displacement. Subsurface accelerations and velocities were only slightly higher than the predictions based almost entirely on high explosive tests (Cowboy). The scatter in surface acceleration, velocity, and displacement allows no precise conclusions on the relationship between subsurface and surface motion, but they were mostly less than twice the subsurface motions. Spalling of the surface formation was observed out to about 1000 meters. Negligible structural response was observed at the Shell well. This test demonstrated that predictions of free field earth motion at intermediate ranges based on standard scaling laws are satisfactory for range settings in a medium such as halite even when the scaling ratio is large. Measurements at 8000 to 10,000 meters show that extrapolations made from pre-Gnome results were high by an order of magnitude and that the change of frequency (at a fixed range) with charge size was much more pronounced than on pre-Gnome tests. This points up the necessity for designing pre-shot tests to permit true scaling. (auth)

16266 (NASA-TT-F-109) INTERNATIONAL GEOPHYSICAL YEAR BIBLIOGRAPHY OF LITERATURE PUBLISHED IN RUSSIAN IN 1960. R. F. Zatrutina and L. S. Rubina. Translation of "Mezhdunarodnyi Geofizicheskii God. Bibliograficheskii Ukazatel' Literatury na Russkom Yazyke za 1960 g." Moscow, 1961. 189p.

References for 1200 publications issued in 1960 on observations and experiments carried out as part of the IGY program are included. All non-geophysical data are excluded, and the references are arranged in accordance with the IGY program. Abstracts are provided when the titles are not representative of the publication's material. (D.C.W.)

16267 OBSERVATION OF SEASONABLE DEFINITE DETECTION OF RADIOACTIVE PRECIPITATIONS. G. Malkowski (Freien Universität, Berlin). Atomkernenergie, 8: 78-9(Feb. 1963). (In German)

Based on observations by weather radar stations, investigations are made on the probability of detecting all precipitations at individual stations or within a certain measuring network. It is shown that the definite detection of any radioactive precipitations is not guaranteed under many atmos-

pheric conditions even if there is a measuring network comprising several stations. (auth)

16268 DETERMINATION OF THE DIRECTION OF FLOW OF GROUND WATER IN A SINGLE BORE HOLE WITH THE HELP OF RADIOACTIVE ELEMENTS. H. Mairhofer (Bundesversuchs- und Forschungsanstalt Arsenal, Vienna). Atompraxis, 9: 2-4(Jan. 1963). (In German)

A method of estimating the direction of ground-water flow by means of a single well bore-hole with the CrO_2 of radioactive tracers is shown. (auth)

16269 THE ELECTROMAGNETIC FIELD WITHIN A DISCONTINUOUS CONDUCTOR WITH REFERENCE TO GEOMAGNETIC MICROPULSATIONS NEAR A COASTLINE. J. T. Weaver (Defence Research Board of Canada, Victoria, B. C.). Can. J. Phys., 41: 484-95(Mar. 1963).

The two-dimensional problem of a low-frequency, plane-polarized electromagnetic wave incident on a semi-infinite conducting medium with a plane surface is treated for the case when the medium has a discontinuity, the regions on either side of a plane normal to its surface being of different conductivities. Arguments are given to show that it is reasonable to assume, as a low-frequency approximation, that the tangential magnetic field is constant on the surface of the conductor. With the aid of this approximation, solutions are obtained for the two cases when (i) the magnetic vector (H polarization) and (ii) the electric vector (E polarization) is always parallel to the trace of the discontinuity. The model is discussed with reference to the behavior of geomagnetic micropulsations near a coastline, particular attention being paid to the E-polarization solution which contains a magnetic component normal to the surface of the conductor. The amplitude of this component at the surface is shown to increase sharply as the region of the discontinuity is approached, thus providing an explanation of the enhanced Z magnetic component in the micropulsation field observed at coastal stations. (auth)

16270 VARIATIONS OF THE ISOTOPIC COMPOSITION OF POTASSIUM OF DIFFERENT ORIGINS. Gunter Harms, Claude Blanc, Lucien Espagno, and Daniel Blanc. Compt. Rend., 255: 3203-4(Dec. 5, 1962). (In French)

The isotopic abundances of potassium extracted from different rocks were measured using a mass spectrometer. The ratio K^{39}/K^{41} varies with the origin and the age of the rock. On the contrary, the percentage of K^{40} is constant and equal to 115×10^{-6}. (tr-auth)

16271 STUDY OF THE CHARGE OF SMALL RADIOACTIVE IONS AND THEIR FIXATION ON ATMOSPHERIC AEROSOLS. André Renoux. Compt. Rend., 256: 478-80 (Jan. 7, 1963). (In French)

It was established that during the decay of radon in the air, a certain number of electrically neutral recoil atoms, in addition to positively charged atoms, appear. The time of fixation of the latter on natural aerosols was determined, and the contact time of these aerosols and of radon in the atmospheric air was evaluated. (tr-auth)

16272 PERTURBATIONS PRODUCED BY HIGH-ALTITUDE THERMONUCLEAR EXPLOSIONS (PARTICULARLY THAT OF JULY 9, 1962) ON THE PATH LENGTH AND AMPLITUDE OF MYRIAMETRIC WAVES. Bernard Decaux, André Frances, André Gabry, and Michel Reyssat (Centre National d'Études des Télécommunications, Issy-les-Moulineaux, France). Compt. rend., 256: 481-4(Jan. 7, 1963). (In French)

The waves emitted by four emitters of English and American standard frequencies received in the Paris region underwent, during the nuclear explosion of July 9, 1962, a sharp variation of phase and amplitude, which was analyzed as a function of the diverse geographic circumstances. The explosions of October and November disturbed the waves coming from Hawaii. (tr-auth)

16273 THE ABSOLUTE AGE OF THE UPPER PALEOLITHIC PERIOD (SOLUTREAN, GRAVETTIAN TYPE) IN THE REGION ADJOINING THE DNESTER RIVER, DETERMINED BY RADIOCARBON DATING. I. K. Ivanova and A. P. Chernysh. Dokl. Akad. Nauk SSSR, 148: 410-13 (Jan. 11, 1963). (In Russian)

Determination of the age of the dwellings of primitive man is of interest both from the point of view of the stratigraphy of quaternary deposits and for solving anthropogenetic problems. For this reason, radiocarbon dating techniques were used for layers containing paleolithic residue of Molodova V, located in a 200-m deep canyon at the right bank of the Dnester River in the Chernowith region. The measurements were carried out at a depth of 3.1 to 3.25 m from the surface. The age of layer VI was calculated at 23,000 ± 800 years which is close to the age reported for the Czechoslovak gravette and from samples from the French Abri plateau. Thus, radiocarbon dating results confirmed earlier findings obtained by topological means concerning the age of the region near the Dnester River. (TTT)

16274 THE PRIMORDIAL TRANSURANIUM ISOTOPE IN NATURE. V. V. Cherdyntsev and V. F. Mikhailov (Geological Inst., Moscow). Geokhimiya, No. 1, 3-14(Jan. 1963). (In Russian)

In some young natural samples a primordial radioactive α-emitter is obtained. The α-spectrum main line extends from 4.2 to 4.6 Mev and the gamma rays have the energy in the region: 90 to 250 kev. This isotope, apparently, is Cm^{247}. Decay products of Am^{243} and Pu^{239} accompany it. The Cm^{247} content in natural minerals is about $n \times 10^{-8}$% and $Cm^{247}/U^{238} = n \times 10^{-2}$ (activity units). The decay period of the isotope is estimated as 2.5×10^8 years. (auth)

16275 ON THE ZrO_2/HfO_2 RATIO IN ZIRCONS FROM THE ALKALINE COMPLEX OF THE VISHNEVYE-ILMENSKIE MOUNTAINS. E. B. Khalezova and L. I. Sosnovskaya (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Moscow). Geokhimiya, No. 1, 68-78 (Jan. 1963). (In Russian)

Zircon is a widely spread accessory mineral in the alkaline rock complex of the Vishnevye and Ilmenskie Mountains. The value of the ZrO_2/HfO_2 ratio in zircons ranges from 22 to 125 and so distinctly agrees with the relative age of zircon-containing pegmatites, increasing from earlier to later ones so that it may be a criterion of the relative zircon age. The considerably higher value of the ZrO_2/HfO_2 ratio in zircons from pegmatites allows one to conclude that the formation of zircons in miaskites is connected with the final albitization stages in the massif. (auth)

16276 PRECIPITATION OF U IN BLACK SEA. S. Sh. Agamirov. Geokhimiya, No. 1, 92-3(Jan. 1963). (In Russian)

Hydrochemical tests of the northeast portion of the Black Sea Basin during July 1961 indicated 2.4 g/l U in the upper 500-m layer, 1.6 g/l U between 1000 and 1800 m, and much smaller amounts at greater depths. Further studies showed the feasibility of hexavalent uranium reduction to tetravalent by hydrogen sulfide contamination, followed by a pre-

cipitation to a depth of 1700 to 2000 m where the eH value is 0.15 to 0.20 v, resulting in an enrichment of Black Sea sediments. (R.V.J.)

16277 REGULARITIES OF THE TR DISTRIBUTION IN THE CRUST OF THE EARTH. Yu. A. Balashov. (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Geokhimiya, No. 2, 99-114(1963). (In Russian)

Correlative ratios of rare earth elements were established and systematics of composition and content of rare earth elements in rocks of the Earth's crust were carried out. Maximum variations of rare earth elements are observed in alkaline rocks and granites. In the average massifs formed by alkaline rocks and granitoids are characterized by a strong prevalence of the ceric groups in comparison with ultrabasic and basic rocks. All rocks of the Earth's crust (including sedimentary and metamorphic) are distinguished by a higher content of rare earth elements (being relatively enriched in the ceric group) in comparison with the silicate phase of chondrites, assumed to be analogous to the matter of the mantle. The latter is probably connected with dissemination chiefly of the yttric group of rare-earth elements in the deep-seated differentiates of the mantle (dunites) owing to the isomorphic entering of the rare-earth elements into Fe-Mg-silicates. (auth)

16278 ON THE INTERRELATION BETWEEN THE TOTAL CONTENT AND THE COMPOSITION OF RARE EARTHS IN MINERALS. A. P. Khomyakov (Inst. of Mineralogy, Geochemistry and Crystal Chemistry of Rare Elements, Moscow). Geokhimiya, No. 2, 115-21(1963). (In Russian)

It is established that the total TR content in minerals with low coordination numbers (6 to 8) of the replaced elements increases from ceric to yttric variants; the TR content in minerals with high c.n. (9 to 12) of the replaced elements increases from yttric to ceric variants. The presence of minor quantities of impurities in minerals which some authors explain by endocryptia is in accordance with the general laws of isomorphism. At the same time, the influence of crystallochemical factors on the ability of elements for isomorphism decreases with the concentration decrease of isomorphous impurities. The effective sizes of ionic radii for the elements of different periods change irregularly with the alteration of coordination numbers. As a result of this isomorphous capacity of the minerals in relation to isomorphous impurities changes according to the alteration of the replaced elements c.n. (auth)

16279 THE SPECTRUM OF THE SIZE DISTRIBUTION OF NATURAL RADIOACTIVE AEROSOLS. K. P. Makhon'ko. Izv. Akad. Nauk SSSR, Ser. Geofiz., No. 1, 183-7 (Jan. 1963). (In Russian)

The size distribution spectrum of natural radioactive aerosols with $r < 7 \times 10^{-6}$ cm consists of a series of maxima. The maximum distribution curve at $r \sim 10^{-6}$ to 10^{-6} cm is stable and is described by the formula $r_n^{max} = r_0 \times 2^n (n = 0, 1, 2 \ldots)$. (R.V.J.)

16280 THE DISTANT GEOMAGNETIC FIELD. 3. DISORDER AND SHOCKS IN THE MAGNETOPAUSE. C. P. Sonett (National Aeronautics and Space Administration, Washington, D. C.) and I. J. Abrams. J. Geophys. Res., 68: 1233-63(Mar. 1, 1963).

The procedure for analysis of fluctuation phenomena in the geomagnetic field is extended to study finite disturbances in amplitude and direction at distances of 12.3–14.6 earth radii on the sunlit hemisphere of the magnetopause (magnetospheric-interplanetary transition region). The appearance of large and small excursions in both field amplitude and direction suggests a high stirred or turbulent plasma of $\beta \sim 1$ in this region of space on the day of this flight. The directional changes are generally reversals in polarity and precede the most extreme pulses. The data are characterized by many finite-amplitude pulses suggestive of collisionless waves such as might typify the microstructure of a shocked region in the collisionless domain. These pulses have crests of extreme sharpness, suggesting the possibility of radiative dissipation. Moreover, the front-back symmetry, together with satellite pulse structure, is consistent with damping by either the mechanism of Gardner and others or that of Petschek. Power spectrums of both longitudinal and transverse excitation were computed. The longitudinal (compressive) energy density is generally $\sim 10^{-9}$ erg/cm^3; the transverse energy density is $\sim 10^{-10}$ erg/cm^3. The longitudinal half-power frequency increases from 2 to 4 rad/sec in traversing outward through this segment of the field. The large depression in power and the arithmetic mean field values for the greatest distance suggest a geomagnetic or interaction termination at 14.6 Re. Arguments are given to show that, within the scope of this experiment, the planar or two-dimensional view of these phenomena do not qualitatively modify the observations. In the discussion of power spectrums the assumption $\partial H/\partial t \ll \omega H$ (the unimportance of folded contributions) is adhered to and forms the framework for certain of the conclusions discussed. (auth)

16281 THE DISTANT GEOMAGNETIC FIELD. 4. MICROSTRUCTURE OF A DISORDERED HYDROMAGNETIC MEDIUM IN THE COLLISIONLESS LIMIT. C. P. Sonett (National Aeronautics and Space Administration, Washington, D. C.). J. Geophys. Res., 68: 1265-94(Mar. 1, 1963).

The fine-scale structure of magnetic field data is examined. The front slopes of the large pulses generally rise to peak value in about 1 second. The rear slopes apparently decay exponentially, often with a satellite structure having a period about one-sixth that of a medium fixed with respect to the magnetometer, suggesting strong Doppler shifting. Thus, the assumption of a Larmorlike periodicity for these satellite pulses indicates an Alfvén Mach 6 velocity away from the spacecraft. The large pulses (hyperwaves) also appear to be consistent with collisionless, finite-amplitude hydromagnetic pulses. The slope asymmetry is in qualitative accord with theoretical views, i.e., an anisotropic plasma pressure and/or first-order dissipation and relaxation. The power spectrums for neither $H_\perp$ nor Ψ^* are Kolmogoroffian. The $H_\perp$ spectrums are generally compatible with a two-step process; Ψ^* (vorticity) spectrums have increasing power density with wave number. Velocity bounds provide a scale size for both the hyperwaves and the eddy distribution. The condition $\partial H/\partial t \ll \omega H$ necessarily forms the basis for certain of the conclusions drawn, especially those just enumerated. The steeply peaked pulse profile implies large crest electric fields due to the Hall effect. Acceleration of charged particles is suggested and is in consonance with a cosmic-ray view of this region of space on Pioneer 4 and the theory of Morawetz. The conclusion that the pulses are primarily magnetoacoustic with a preponderance of propagation vectors directed earthward is in keeping with the conclusion that the hydromagnetic excitation mechanism was a source function of large scale with respect to the magnetosphere. The existence of a copious supply of field reversals always followed by a pulse lends support to a model in which hypersonic gas bubbles are

propagating into the vestigial field, inertial reaction creating the pulse and a condition of minimum field potential energy being achieved by twisting of tubes of force on the upstream boundary (magnetopause model). An alternative model implies a large bowlike shock wave, the shock microstructure being fine-scale collisionless pulse phenomena like those suggested in the type of wave studied by Davis, Lüst, and Schlüter. This last model, however, requires the generation of an exotic ad hoc mechanism to provide plasma instability leading to the X-type nulls often associated with the waves. The termination of activity at about 14 Re would suggest magnetic termination on the leading edge of the macroscopic shock. The identical termination distance on Pioneer 4 with cosmic-ray pulses seen as far into the field as 10 Re where the dipole magnitude becomes appreciable favors the magnetopause model over any simple structure such as a detached bow shock. (auth)

16282 A NOTE ON THE COMPRESSION OF THE EARTH'S MAGNETIC FIELD AND HYPOTHETICALLY RELATED PHENOMENA. Louis R. Henrich (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 68: 1295-1302 (Mar. 1, 1963).

The magnetic field of the earth is assumed compressed by an incident stream of ionized particles from the sun. A time-dependent magnetic and electric field is propagated as part of this interaction. A simplified model, a mirror dipole moving in space but of constant magnetic moment, is chosen to calculate the manner in which this electric field will compress and possibly accelerate ions already trapped in the earth's magnetosphere. This model would tend to dump radiation from the terrestrial belts into the atmosphere. For geometrical reasons the effects might be most pronounced in early morning and late evening. (auth)

16283 THE EFFECT OF THE EARTH'S MAGNETIC FIELD ON IRREGULARITIES OF IONIZATION IN THE E LAYER. F. Villars and H. Feshbach (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 68: 1303-20 (Mar. 1, 1963).

It was suggested that auroral backscattering of radio waves in the frequency range 100–800 Mc/s is a consequence of the joint action of turbulence and the earth's magnetic field, which was assumed to produce small-scale elongated irregularities of ionization lined up with the earth's field. Solutions of the equation for diffusion and transport of ionization in a weakly ionized turbulent plasma in the presence of a magnetic field are investigated. Because of space charge effects, the problem is nonlinear in the ionization density n(x,t). It is shown that in the linearized approximation the effect of the magnetic field on turbulence does not lead to irregularities of a scale sufficiently small to explain the observed data. Nonlinear effects may play a role and are being investigated. Preliminary results show that they are indeed capable of increasing density gradients in irregularities of sufficient amplitude. (auth)

16284 A MODEL OF THE QUIET IONOSPHERE. J. Carl Seddon (National Aeronautics and Space Administration, Greenbelt, Md.). J. Geophys. Res., 68: 1339-45 (Mar. 1, 1963).

Analysis of high-altitude rocket electron and ion density measurements suggests a simple model of the quiet ionosphere. Near $h_{max}F_2$ the profile is given by the "α-Chapman" function, i.e., the Chapman electron density equation with sec $\chi = 1$ and the "scale height" H a constant. A method is given for determining $h_{max}F_2$, $N_{max}F_2$, and H from N(h) data obtained from ionograms. Well above the peak, the profile is taken to have a constant exponential slope of 200 km during the day and 150 km during the night. If simultaneous nearby measurements of the total electron content are available, a more accurate slope can be computed, thus providing the profile up to about 1000-km altitude. (auth)

16285 THE INFLUENCE OF THE MOON ON GEOMAGNETIC DISTURBANCES. E. K. Bigg (Commonwealth Scientific and Industrial Research Organization, Sydney). J. Geophys. Res., 68: 1409-13(Mar. 1, 1963).

It is shown that occurrences of geomagnetic disturbances of various intensities are not uniformly distributed in lunar phase. There is a tendency for storms to occur preferentially near first and third quarters and to avoid dates corresponding to new moon. (auth)

16286 COMPARISON OF AMPLITUDES OF SEISMIC WAVES FROM NUCLEAR EXPLOSIONS IN FOUR MEDIUMS. Glenn C. Werth and Roland F. Herbst (Univ. of California, Livermore). J. Geophys. Res., 68: 1463-75 (Mar. 1, 1963). (UCRL-6962)

Particle velocity measurements just beyond the region of plastic deformation were used in calculating the reduced displacement potential of the nuclear explosions: Rainier, 1.7 kt in tuff; Fisher, 13.5 kt in alluvium; Hardhat, 5 kt in granite; and Gnome, 3.5 kt in salt. After scaling to 5 kt, the potentials are convolved with the response of the Benioff instrument and with an attenuation operator appropriate for distances of approximately 500 km. The resultant amplitudes normalized to tuff are tuff 1, alluvium 0.25, granite 1.11, and salt 1.61. Models of the crust of the earth are developed for the four explosions, and the amplitudes of the arrivals from the Mohorovicic discontinuity are calculated using methods previously developed by the authors. The ratios then become tuff 1, alluvium 0.18, granite 2.26, and salt 2.11. These ratios are for the amplitude of the first half-cycle of motion. The theoretical amplitude-distance curves for explosions in tuff, alluvium, granite, and salt for the first 500 km are in agreement with the experimental values recorded by the Air Force Technical Applications Center for the nuclear explosions Antler, Logan, Blanca, Fisher, Hardhat, and Gnome. (auth)

16287 GENERATION OF SEISMIC WAVES BY UNDERGROUND EXPLOSIONS AND THE COLLAPSE OF CAVITIES. Stewart W. Smith (California Inst. of Tech., Pasadena). J. Geophys. Res., 68: 1477-83(Mar. 1, 1963).

The occurrence of large collapse features associated with contained underground nuclear tests in alluvial material provides an unusual opportunity to study the effect of source geometry and time history. The explosion is represented by a pressure pulse applied to a buried spherical cavity, and a collapse by a point force normal to the surface. If the time duration for these sources is 0.16 second and 4 seconds, respectively, the resulting spectral ratio for Rayleigh waves is consistent with the experimental data in the frequency range 0.5 to 3.0 cps. The spectral ratios for SH and SV waves indicate that the SH waves are not generated by near-source phenomena such as movement along joints, but by elastic wave conversion within a few wavelengths of the source. (auth)

16288 THE DISTRIBUTION IN SOILS OF RADIOACTIVITY FROM WEAPONS TESTS. Alan Walton (Isotopes, Inc., Westwood, N. J.). J. Geophys. Res., 68: 1485-96(Mar. 1, 1963).

Results of the vertical profiles of radioactivity from weapons tests in several soils from New Jersey are presented. Four radionuclides, strontium 90, ruthenium 106, cesium 137, and cerium 144, were examined, and in general

the cumulative activities agreed with the quantities estimated from the observed concentrations of the nuclides in precipitation. Vertical distributions of radioactivity within soils appear to vary considerably, and in many instances they can be correlated with certain physical parameters. Permeability and drainage characteristics of the soil and underlying strata are rather important factors in this respect. Strontium 90, a nuclide of particular interest, was distributed on the average with 55 per cent of the total deposit in the top 2 inches, 79 per cent in the top 4 inches, and about 96 per cent in the top 9 inches in 1960. As expected, strontium 90 appears to have penetrated to greater depths than cesium 137. The combined γ activities of the three nuclides yielded a dose rate in 1960 of less than 3 per cent of the maximum external dose rate recommended by the National Committee on Radiation Protection for the general populace. (auth)

16289 DELAY TIME OF POLAR-CAP BLACKOUT AND ITS RELATION TO DELAY TIME OF GEOMAGNETIC DISTURBANCE. Constance S. Warwick (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 1561-2(Mar. 1, 1963).

A simple interpretation is given for the relation between the delay time of polar-cap blackout and the delay time of geomagnetic disturbances. (C.E.S.)

16290 A SUGGESTION FOR IMPROVING FORECASTS OF GEOMAGNETIC STORMS. Y. Hakura and J. Virginia Lincoln (Central Radio Propagation Lab., Boulder, Colo.). J. Geophys. Res., 68: 1563-4(Mar. 1, 1963).

Forecasts of geomagnetic storms may be improved by a technique based on the monitoring of HF transmissions from a station within the north polar cap. (C.E.S.)

16291 THE EFFECT OF A UNIFORM EXTERNAL PRESSURE ON THE BOUNDARY OF THE GEOMAGNETIC FIELD IN A STEADY SOLAR WIND. John R. Spreiter and B. Jeanne Hyett (National Aeronautics and Space Administration, Moffett Field, Calif.). J. Geophys. Res., 68: 1631-42(Mar. 15, 1963).

Approximate solutions are given for the shape of the boundary separating the geomagnetic field from the interplanetary plasma for a model that assumes the plasma pressure to be composed of two components. One is a dynamic pressure proportional to the normal component of the momentum of the particles of a steady and undisturbed uniform incident stream as is customary in the usual formulation of the steady-state Chapman-Ferraro problem. The other is a static pressure considered constant over the boundary surface. Results are determined for the traces of the boundary in the equatorial plane and in the meridian plane containing the sun-earth line for a complete range of values for the ratio between the two pressure components. Only the case in which the dipole axis is normal to the direction of the incident stream is considered, however. The principal qualitative feature of including the effect of a uniform external pressure is that the geomagnetic field terminates at a finite distance from the earth in the antisolar direction that is only a moderate multiple greater than in the solar direction for all but extremely small ratios of static to dynamic pressure. This result indicates that the asymmetry between the distances to the boundary of the geomagnetic field on the day and night sides of the earth may be greatly exaggerated by the results of the usual calculations in which the static pressure is disregarded. (auth)

16292 DETECTION OF IONIZATION EFFECTS FROM NUCLEAR EXPLOSIONS IN SPACE. Richard Latter and Robert E. LeLevier (RAND Corp., Santa Monica, Calif.). J. Geophys. Res., 68: 1643-66(Mar. 15, 1963).

The detection of nuclear explosions in space by observing the effects of explosion-induced ionization on the absorption of radio waves is considered. Ionizations due to explosion x rays, γ rays, and β rays are considered separately, and the dependence of the absorption on explosion characteristics, distance from the earth's atmosphere, and frequency of the radio wave is determined. (auth)

16293 THE DYNAMICAL MORPHOLOGY OF THE AURORA POLARIS. Syun-Ichi Akasofu (Univ. of Alaska, College). J. Geophys. Res., 68: 1667-73(Mar. 15, 1963).

Simultaneous changes of auroral form, brightness, and motion over the whole polar region are studied, using IGY all-sky camera records from widely distributed stations in eastern Siberia, Alaska, Canada, northern United States (south of the Canadian border), and Greenland. During very quiet periods, and sometimes for brief intervals during magnetic storms, the aurora may consist of faint, diffuse, quiet arcs extending along the whole of the auroral zone that is in darkness. The onset of a polar magnetic substorm suddenly changes this quiet state of the aurora, especially on the morning part of the auroral zone. The aurora becomes active all along the zone, but in different ways at different local times, that is, at different positions relative to the midnight meridian. Active auroral displays last for a few hours, 1 to 3, for example. Great auroral displays consist of an intermittent succession of such active periods. Large-scale dynamical features of the auroras, such as the breakup, formation of large loops, and drift motions, are discussed. (auth)

16294 WHISTLER EVIDENCE OF A 'KNEE' IN THE MAGNETOSPHERIC IONIZATION DENSITY PROFILE. D. L. Carpenter (Stanford Univ., Calif.). J. Geophys. Res., 68: 1675-82(Mar. 15, 1963).

Study of a new whistler phenomenon shows that the magnetospheric ionization profile often exhibits a 'knee,' that is, a region at several earth radii in which the ionization density drops rapidly from a relatively normal level to a substantially depressed one. The new whistler phenomenon (called, for convenience, the 'knee whistler') is compared with ordinary whistlers and is illustrated by a number of examples recorded at middle- and high-latitude stations. It is suggested that the knee exists at all times in the magnetosphere, and that its position varies, moving inward with increasing magnetic activity. There are indications that conditions of whistler-mode propagation may be unusually favorable on the low-latitude side of the knee and that the region on the high-latitude side may be favorable for the production of triggered ionospheric noise. It is pointed out that knee whistlers account for a substantial number of the observations of deep density depressions during magnetic storms. Several questions of interpretation are raised, and the direction of future investigations is indicated. (auth)

16295 THE EFFECTS OF POLAR-CAP ABSORPTION ON HF OBLIQUE-INCIDENCE CIRCUITS. Doris H. Jelly (Defence Research Telecommunications Establishment, Ottawa). J. Geophys. Res., 68: 1705-14(Mar. 15, 1963).

Data from HF oblique-incidence ionosonde circuits were studied to determine to what extent they were affected by the radio absorption events now known as polar-cap absorption (PCA). The data were recorded on three circuits terminating in Ottawa (from Churchill, Resolute Bay, and The Hague) and on a fourth circuit between Churchill and Resolute Bay. A relatively weak event caused an apprecia-

ble decrease in the range of usable frequencies on the Canadian circuits. More intense absorption resulted in blackout conditions on all circuits, including the transatlantic. The effects on these circuits could be interpreted from a consideration of the geometry of the propagation modes involved and of the pattern of PCA events that was established with other experimental equipment, particularly riometers. The regular oblique ionosonde data on the Ottawa-Resolute Bay circuit were supplemented for a short time by amplitude measurements. These data showed that, although PCA reduced the signal strength on all frequencies received, the noise was absorbed at the same time; hence, the signal-to-noise ratio was not appreciably affected. This result is probably dependent on the location of the circuit. (auth)

16296 ON THE FREQUENCY CUTOFF OF HYDROMAGNETIC WAVES IN THE UPPER ATMOSPHERE. S. L. Kahalas (Mt. Auburn Research Associates, Cambridge, Mass.). J. Geophys. Res., 68: 1776-8(Mar. 15, 1963).

Several mechanisms that prevent the observation at the earth's surface of a geomagnetic disturbance in the exosphere with frequency higher than the observed cutoff frequency are presented. Cutoff can be caused by the Hall effect in the ionosphere, dissipation, or a generation mechanism caused by solar plasma. (C.E.S.)

16297 EFFECTS OF THE HIGH-ALTITUDE THERMONUCLEAR EXPLOSION OF JULY 9, 1962, 0900 UT, OBSERVED AT JAMAICA. R. J. Armstrong and A. E. B. Wharton (Univ. of West Indies, Jamaica). J. Geophys. Res., 68: 1779-80(Mar. 15, 1963).

Soon after the high-altitude explosion of July 9, 1962, the cutoff frequency on the ionogram increased threefold on the NBS C3 ionosonde at Jamaica. (C.E.S.)

16298 DISTANT ELECTROMAGNETIC OBSERVATIONS OF THE HIGH-ALTITUDE NUCLEAR DETONATION OF JULY 9, 1962. G. M. Crook, E. W. Greenstadt, and G. T. Inouye (Space Tech. Labs., Redondo Beach, Calif.). J. Geophys. Res., 68: 1781-4(Mar. 15, 1963).

Data obtained by VLF and ELF signals of large amplitude after the July 9 test at an observing site near Los Angeles are summarized. (C.E.S.)

16299 MEASUREMENT OF CESIUM FALL-OUT IN THE PACIFIC OCEAN AND IN TERRESTRIAL EFFLUENTS LIKELY TO AFFECT COASTAL WATERS. T. R. Folson and G. J. Mohanrao (Univ. of California, La Jolla and California Inst. of Tech., Pasadena). J. Radiation Res., (Japan), 1: 150-4(1960).

A chemical technique was developed for concentrating traces of Cs^{137} fallout in sea water (and in sewage), so that assay can be made rapidly with a γ spectrometer. Measurements were made of Cs^{137} in surface waters of the eastern Pacific, especially near the shore, and data are compared with fallout contamination reported elsewhere. Also, a contemporary vertical profile of Cs^{137} activity in the Pacific is given. The behavior of fallout activity in a large modern sewage treatment plant and in its oceanic outfall is discussed, and estimates are made of the probable effects in coastal areas. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

16300 VARIATION OF Cs-137 IN CALIFORNIA COASTAL SEA WATER. T. R. Folsom (Scripps Institution of Oceanography, La Jolla, Calif.) and G. J. Mohanrao. J. Radiation Res. (Japan), 3: 1-3(Mar. 1962). (In English)

Repeated measurements of specimens of surface sea water taken at a single nearshore, coastal, sampling point fluctuated widely, from 0.046 to 0.23 $\mu\mu$C/l. The results were consistent with other measurements made off California, but much lower than those reported for the Western Pacific. (auth)

16301 DISCREPANCY IN AGE-DETERMINATION INVOLVING RADIOGENIC ISOTOPES OF LEAD. Akimasa Masuda (Tokyo Univ.). Nature, 197: 892-3(Mar. 2, 1963).

Discrepancy in age-determinations for radioactive materials involving radiogenic isotopes of Pb is discussed. It is postulated that the oxidation state of U affects the stability of radiogenic Pb, since bond-strength of the oxide depends on the oxidation state. Data are presented from calculations of the relative instabilities of Pb^{208}, Pb^{206}, and Pb^{207} in ThO, UO_3, U_3O_8, and UO_2. (C.H.)

16302 PHOTOMETRIC OBSERVATIONS FROM THE SOUTHERN HEMISPHERE OF 5577A EMISSION FROM THE AURORA ON OCTOBER 28, 1961. C. T. Lewis (Dominion Physical Lab. Auroral Station, Omakau, N. Z.). Nature, 197: 992-3(Mar. 9, 1963).

On the night of October 28, 1961, a bright aurora was observed at Lauder, New Zealand, 170°E, 45°S geographic, 50°S geomagnetic. This aurora, which consisted of an active rayed arc, was observed with a photometer specifically designed to look for rapid variations in afterglow and was photographed with an all-sky camera run in conjunction with the photometer. A photometer trace for the period of 1135 to 1235 U. T. of 5577A emission and a photograph taken during the same period are presented. Comparison with fluctuations in 5577A airglow emission intensity at Sacramento Peak, geomagnetic latitude 41.6°N, at the same time indicates considerable auroral activity in both hemispheres. (C.H.)

16303 GEOCHEMICAL STUDIES IN THE URANIUM PROSPECT AT UMRA, RAJASTHAN. I. GEOCHEMISTRY OF WATERS. V. V. S. S. Tilak and U. Aswathanarayana (Andhra Univ., Vizagapatam, India). Proc. Indian Acad. Sci., Sect. A, 57: 34-43(Jan. 1963). (In English)

With the objective of investigating the geochemistry of the natural waters of the uranium prospect at Umra, Rajasthan, the concentrations of uranium, nickel, cobalt, copper, vanadium, etc., in the natural waters were determined and their distribution patterns were interpreted in the light of the geology of the area, the climatic and hydrological conditions prevalent there and the geochemical behavior of the elements concerned. It is found that there is a marked contrast in the uranium content of winze and well waters. The presence of copper in waters despite their high pH is ascribed to the tendency of copper to form colloidal suspension of basic carbonates. The observation, that vanadium is present in the secondary uranium-vanadium minerals but is absent in the waters, could be explained in the light of the geochemical behavior of the element. The concentration of cobalt in most of the water samples and its absence in some are traceable to the controlling effect of pH on the mobility of cobalt. Nickel in waters might have been "scavenged" and absorbed on hydrated iron oxides, which explains the absence of nickel in waters. Mention is made of the health hazard involved in drinking water from one of the wells with high content of uranium. (auth)

16304 CONTAMINATION LEVEL AND DISTRIBUTION OF RADIOACTIVE CERIUM IN HUMANS AND ANIMALS UNDER NATURAL CONDITIONS. L. G. Shakhidzanyan (Sechenov Inst. of Evolution Physiology, Leningrad). Radiobiologiya, 2: 838-42(1962). (In Russian)

An attempt was made to determine the selective distribution of Cs^{137} in human and animal organs under natural con-

ditions and to determine the contamination level in the Leningrad area as a result of nuclear test explosions. The tabulated data show the highest Cs^{137} uptake in the second half of 1958 and the lowest in 1960. Experiments with 26 men, 57 swine, 21 large cattle, 9 small cattle, and 6 dogs indicated the presence of Cs^{137} in all animal tissues and organs exclusive of their heads. Only one case of Cs^{137} in the human brain was found; in a man suffering from brain hemorrhage. (R.V.J.)

16305 RARE-EARTH ELEMENTS IN TEKTITES. Larry Haskin and Mary A. Gehl (Univ. of Wisconsin, Madison). Science, 139: 1057-8(Mar. 15, 1963).

The rare-earth element content of three tektites was determined by neutron activation analysis. The relative abundance patterns are all nearly alike and are identical to the pattern characteristic of well-differentiated terrestrial sediments. Possible consequences of finding this pattern in truly extraterrestrial matter are considered. (auth)

16306 THEORETICAL BASIS FOR LOGARITHMIC CORRELATIONS OF FRACTIONATED RADIONUCLIDE COMPOSITIONS. Edward C. Freiling (Naval Radiological Defense Lab., San Francisco). Science, 139: 1058-9 (Mar. 15, 1963).

A theoretical basis for logarithmic correlations of fractionated radionuclide compositions is described. Implications for nuclear chemical studies of bomb debris and application to the prediction of partition of Sr^{90} and other biologically important radionuclides among particles of various sizes, and consequently between local and worldwide fallout, are indicated. (auth)

16307 CHEMISTRY OF THE UPPER ATMOSPHERE. Robert F. Fellows (National Aeronautics and Space Administration, Washington, D. C.). Preprint Paper No. 63-4. New York, Institute of the Aerospace Sciences, 1963. 14p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

The composition and associated energy relations of the upper atmosphere were considered. Certain changes became apparent in the composition of the atmosphere as a function of altitude. The major chemical reactions in the atmosphere were discussed, and a brief description of the ionosphere is given. (C.E.S.)

16308 ALGEBRAIC AND GRAPHIC METHODS FOR EVALUATING DISCORDANT LEAD-ISOTOPE AGES. L. R. Stieff, T. W. Stern, and R. N. Eicher (Geological Survey, Washington, D. C.). Geological Survey Professional Paper 414-E. 1963. 27p. (GPO)

The calculated lead-isotope ages of many uranium-bearing minerals yield the following discordant age sequence: $Pb^{206}/U^{238} < Pb^{207}/U^{235} \ll Pb^{207}/Pb^{206}$. In the literature these and the reverse discordant lead-isotope age sequences are usually attributed to loss or gain of lead or uranium or an intermediate uranium daughter product. An alternative interpretation, generally not stressed, is that this failure of the lead-uranium and lead-lead ages to agree may also be a consequence of the deposition of an older generation of radiogenic Pb^{207} and Pb^{206} at the time of formation of the uranium-bearing mineral. Also, the calculated lead-isotope ages of many uranium- and thorium-bearing minerals yield Pb^{208}/Th^{232} ages which are less than the lead-uranium and lead-lead ages obtained on the same sample. The usefulness of the Pb^{208}/Th^{232} age has been reduced because of the difficulties encountered in evaluating these age discrepancies. Graphic solutions for the discordant lead-uranium age problem that are available in the literature have been amplified and extended to cover corrections for common lead without using either Pb^{204} or Pb^{208} as the common-lead index. Where isotope studies have been made on two or three samples of the same age and from the same deposit or formation, a new graphical procedure using the index isotope is presented that will yield concordant ages corrected for both lead loss and original radiogenic lead. These concordant ages may be obtained without knowledge of either the amounts or the isotopic compositions of the contaminating common lead, the Pb^{207}/Pb^{206} ratio of original radiogenic lead, or the extent of past or recent alteration if original radiogenic lead is not present. A new set of age equations has also been developed which permit algebraic solutions of the problems of original radiogenic lead and lead loss that are equivalent to the solutions obtained graphically. The derivation of these equations may also be considered as proof of the graphical constructions. A table of factors is provided in order that either exact lead-loss or original radiogenic lead solutions may be obtained from the age equations expanded only to the second degree. The general form of these new age equations is also given for programing on computing machines. The latter equations give both the concordant ages corrected for original radiogenic lead and for loss of lead. Both the graphic and algebraic solutions are applicable to the discordant thorium-uranium age problem. The algebraic and graphic treatments of discordant lead-isotope ages define both the type and minimum number of samples necessary for adequate mathematical analysis of the problem. This mathematical treatment also makes it clear that discordant lead-isotope age data alone cannot provide the basis for the choice of an age corrected for loss of lead or old radiogenic lead. The most reasonable age can be selected only after careful consideration of independent geochronologic data as well as field, stratigraphic, and paleontologic evidence, and the petrographic and paragenetic relations. (auth)

HEALTH AND SAFETY

16309 (AD-297559) SETTLING AND FILTERING EQUIPMENT FOR ROOF-WASHDOWN RADIOLOGICAL COUNTERMEASURES. Technical Report R-219. Type C Final Report. E. N. Hellberg (Naval Civil Engineering Lab., Port Hueneme, Calif.). Feb. 8, 1963. 25p.

Tests were made to determine if radioactive fallout particles can be removed from roof-washdown water by settling and filtering, thus permitting continuous use of the water by recirculation. A settling tank, a filtering tank, a circulating pump, a flocculent injector, and other allied mechanical equipment are used in the tests. The fallout simulant was sand of various particle sizes tagged with a radioactive tracer. Since a roof section was not used in the tests, the simulant was fed directly into a sloping, open channel which returned the wash water from the filtering tank to the settling tank. It was concluded that settling and filtering tanks connected in series permit satisfactory separation of the simulant from the wash water. It was further concluded that a recirculating-water roof-washdown system using settling and filtering tanks is feasible. (auth)

16310 (AFSWC-TDR-62-83) FLIGHT TEST CRITERIA FOR RE-ENTERING NAP SYSTEM. Interim Report. (North American Aviation, Inc. Space and Information Systems Div., Downey, Calif.). Nov. 1962. Contract AF 29(601)-5104. 156p. (AD-295159)

Activities in a study to establish flight-test program criteria are reported. Study results are intended to be universal in application to nuclear auxiliary power systems (NAP) re-entry investigations. The SNAP 10A was selected as a representative system for study. Discussions are included concerning orbital decay, thermodynamic aspects, scaling, instrumentation, launch vehicles and sites, and reliability. Significant among interim conclusions reached is that a 300,000-ft re-entry altitude can be used. (J.R.D.)

16311 (AHSB(RP)R-20) ACCUMULATED DOSE RECEIVED IN 13 WEEKS AND 50 YEARS BY BODY TISSUES FROM ONE MICROCURIE SINGLE INTAKE BY INHALATION OR INJECTION THROUGH A WOUND. G. W. Dolphin (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch. Radiological Protection Div., Harwell, Berks, England), A. Fairbairn, and T. Murphy (United Kingdom Atomic Energy Authority. Authority Health and Safety Branch, Risley, Lancs, England). June 19, 1962. 77p.

Calculations were made of the radiation dose accumulated by body tissues in 13 weeks and in 50 years due to the inhalation or injection through a wound of one microcurie of any of 226 radionuclides listed in the sales catalog. The FORTRAN IBM-704 program used in the calculations is included. (C.H.)

16312 (ANL-6688) A REVIEW OF THE ARGONNE NATIONAL LABORATORY RADIATION EXPOSURE EXPERIENCE FOR THE YEARS 1959–1961. Pete Tedeschi (Argonne National Lab., Ill.). Feb. 1963. Contract W-31-109-eng-38. 38p.

A general analysis of the Argonne National Laboratory experience with radiation exposure of employees was made by means of machine-processed records. Distribution of employee exposures according to age, years of employment, laboratory division, job group, and sex were determined for a three-year period. A 23.6% increase in the number of employees monitored occurred from 1959 to 1961. The number of measurable exposures increased 107%. The greatest influence on the increase in measurable exposure was probably due to a change to a more sensitive film and from a one-week to a two-week film-wearing period. Evaluation of performance using the factors frequency rate, exposure rate, and average exposure revealed that the radiation safety program is improving in effectiveness. The exposure rate was reduced by as much as 71.1%, and the average exposure was reduced 42.4%. (auth)

16313 (EURAEC-292) DESIGN AND ECONOMIC STUDY OF SPENT FUEL SHIPPING. Quarterly Report No. 4, January 1, 1962 to March 31, 1962. Gerald Fisher (Stanray Corp., Chicago). Mar. 26, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-963. 7p.

A study of the problems involved in the shipment of spent radioactive fuel elements from the SENN reactor located in Italy to a reprocessing site in the United States is discussed. All applicable rules, regulations, and matters of procedure limited to United States territory and the high seas is included in this study. (H.G.G.)

16314 (LADC-5343) CURRENT PROBLEMS AND NEW DEVELOPMENTS IN RESPIRATORY PROTECTION. E[dwin] C. Hyatt (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract [W-7405-eng-36]. 42p.

Problems in the development of respiratory protective devices are discussed. Results are reported from an evaluation of respirators and gas masks for protection against radioactive particulates. Emphasis is placed on recent developments. (C.H.)

16315 (LADC-5359) NEUTRON DOSE ESTIMATES IN THE SL-1 ACCIDENT. D. F. Petersen (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 9p.

Measurements of the P^{32} activity presumably arising from neutron activation of hair obtained at autopsy from victims of the SL-1 reactor accident permitted estimates of the fast neutron doses sustained by personnel, their position at the time of the critical excursion, and have provided an independent estimate of the magnitude of the critical excursion. Fast neutron doses ranged as high as 10^5 rads, the operators appeared to be in positions consistent with a particular phase of reactor operation, and the extent of the excursion suggested by these data is estimated to be approximately 3×10^{18} fissions. (auth)

16316 (LADC-5410) RESPIRATORS FOR PROTECTION AGAINST AIRBORNE RADIOACTIVE CONTAMINANTS. E. C. Hyatt (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 45p.

The AEC Respirator Committee specifications for respiratory protective devices against uranium compounds and highly toxic contaminants are reviewed. The testing of commercially available devices in relation to these specifications are discussed. Results are presented for commercial masks tested at temperatures down to –30°F. Limitations on the selection and use of respirators are discussed. (C.H.)

16317 (NAA-SR-Memo-8151) NUCLEAR SAFETY IN HALLAM UC FUEL SHIPMENT. Norman Ketzlach

(Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 22, 1963. Contract [AT(11-1)-Gen-8]. 6p.

Nuclear safety aspects of shipping the fuel for eight 3.7% U^{235} enriched UC elements with two 4.9% U^{235} enriched UC elements were evaluated. Results of the evaluation indicate that it is safe to ship these 10 elements, required for the HNPF Core I, loaded in a single shipment. Packaging specifications are included. (J.R.D.)

16318 (NP-12629) PROPOSED SAFETY STANDARD FOR DESIGN, FABRICATION AND MAINTENANCE OF STEEL CONTAINMENT STRUCTURES FOR STATIONARY NUCLEAR POWER REACTORS. (Sargent and Lundy, Chicago). Nov. 14, 1962. 13p.

A discussion of proposed standards for the design, fabrication, and maintenance of steel containment structures for stationary nuclear power reactors, which would protect the general public from radioactive material dispersal under conditions of accidental violation of primary plant integrity, is presented. (H.G.G.)

16319 (NYO-9674) STRATOSPHERIC MONITORING PROGRAM BIMONTHLY PROGRESS REPORT NO. 4, DECEMBER 1960–JANUARY 1961. S. Cravitt, P. Lilienfeld, and H. Weber (Del Electronics Corp., Mount Vernon, N. Y.). Aug. 22, 1962. Contract AT(30-1)-2363. 33p.

The technical basis for a stratospheric electrostatic precipitator design and the techniques developed to evaluate its performance were reviewed. Test results obtained at simulated altitudes of 85,000 to 120,000 ft with a pilot laboratory unit and a prototype field unit were reported and discussed. At the design flow rate of ambient 100 cfm and with an operating corona current equal to or greater than ½ the design current mass collection efficiencies exceeded 95% for two test aerosols. The larger aerosol had an MMD of 0.16 μ and $\sigma_g = 1.8$, while the smaller aerosol had an MMD of 0.075 μ, and $\sigma_g = 1.8$. (auth)

16320 (NYO-9675) STRATOSPHERIC MONITORING PROGRAM. Summary Progress Report, February 1961–April 1962. M. Lippmann, comp. (Del Electronics Corp., Mount Vernon, N. Y.). Sept. 10, 1962. Contract AT(30-1)-2363. 63p.

The design and operation of electrostatic precipitators for stratospheric sampling are described. Data collected during ten balloon-borne flights at about 110,000 are reported and discussed. Performance data on an experimental altitude gage indicates that the design, which is based on non-self sustained electric discharge, operates effectively at 70,000 to 140,000 ft. A velocity meter for rarefied atmospheres based on the time interval for an ion pulse to traverse a fixed path was found to operate effectively for linear velocities at 150 to 2500 ft/min and under pressures of 200 μ to 30 mm Hg. (J.R.D.)

16321 (ORNL-3401) NUCLEAR SAFETY PROGRAM SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1962. (Oak Ridge National Lab., Tenn.). Mar. 8, 1963. Contract W-7405-eng-26. 84p.

Progress on the nuclear safety research and development program is reported. Topics covered include: physics, chemistry, containment engineering, and radiochemical plants. Progress on the reactor containment handbook is estimated. Separate abstracts were prepared for each of the 8 papers. (M.C.G.)

16322 (ORNL-3401(p.3-4)) REACTIVITY EFFECTS OF SMALL FUEL DISPLACEMENTS IN A POOL-TYPE REACTOR. E. G. Silver (Oak Ridge National Lab., Tenn.)

It was concluded from preliminary results that two-dimensional diffusion-theory codes for calculating reactivity effects of small fuel displacements in pool-type reactors were not adequate for the types of small-geometry, large-cross-section perturbations produced in the first experiments. A slab-reactor experiment is planned to test the adequacy of transport calculation methods. It will be performed at the Critical Experiments Facility at ORNL, with fuel elements that were obtained from the AEC. (auth)

16323 (ORNL-3401(p.5-27)) RELEASE OF FISSION PRODUCTS ON OUT-OF-PILE MELTING OF REACTOR FUELS. G. W. Parker, G. E. Creek, et al. (Oak Ridge National Lab., Tenn.).

Fission-product-release data were obtained by use of two techniques which permit melting of larger amounts of irradiated UO_2 than was possible with previously available techniques. The two scaled-up procedures gave results which are essentially in agreement and which confirm most of the data obtained earlier with milligram amounts of UO_2 irradiated at tracer level. The first method, melting of UO_2 contained in a tungsten crucible surrounded by a helium atmosphere by using r-f heating, gave essentially quantitative release of rare gases and iodine but somewhat lower releases of tellurium and cesium. Essentially no ruthenium or strontium was released. The most apparent explanation of the lower release values observed, as compared with those obtained in earlier small-scale experiments, is that the greatly increased volume-to-surface ratio prevailing in these experiments resulted in a longer diffusion path for the fission products. The lack of oxygen in the helium atmosphere also helped to reduce ruthenium volatility. The second method, melting of cored UO_2 pellets surrounding a tungsten resistor, permitted a comparison of the effect of two different metal cladding materials on fission product release. It was found that stainless steel cladding simply segregated and had little effect on release as compared with that observed from unclad UO_2. Molten Zircaloy, however, apparently wet the UO_2, producing a decreased tellurium release by a factor of 100 and an increased strontium release by a factor of almost 10. A possible interpretation of this phenomenon is that the molten zirconium spreads over the surface of the UO_2 and serves as a getter for excess oxygen and for metals such as tellurium, with which it alloys readily. The lower availability of oxygen would be expected to result in increased volatility of strontium, because the metal is more volatile than the oxide. It was also noted that the usual ratio of 2 to 3 times as much barium as strontium release was reversed in this case. Hot-cell construction is under way to permit the melting of larger quantities of irradiated UO_2 in tungsten crucibles and the clad UO_2 specimens currently being irradiated. An ultra-high-frequency generator was tested for use in both programs. (auth)

16324 (ORNL-3401(p.27-35)) RELEASE OF FISSION PRODUCTS ON THE IN-PILE MELTING OR BURNING OF REACTOR FUELS. W. E. Browning, Jr., C. E. Miller, Jr., et al. (Oak Ridge National Lab., Tenn.).

The series of experiments in the ORR previously described is being continued to study the amounts and forms of fission products released during simulated reactor accidents. The first type of experiment consists of melting or vaporizing a miniature stainless-steel-clad UO_2 fuel element in a helium atmosphere. The second type consists of burning in air a miniature fuel element composed of

spheroidal particles of uranium carbide coated with pyrolytic carbon and embedded in a graphite matrix. In each case, fission and gamma heat raised the temperature of the fuel element sufficiently to cause destruction. In the experiments with UO_2, nearly all the I, Te, and Cs and more than half the Sr, Zr, Ru, Ba, and Ce were released from the fuel. Release of the latter group of fission products and uranium from the high-temperature zone is generally less than 3%. This decrease in release values from fuel to high-temperature zone is considered to be significant since during an actual reactor accident temperatures corresponding to those of the high-temperature zone would probably occur only within the reactor containment. In the experiment with UC_2-graphite, fuel release values were lower except for ruthenium, which probably formed volatile ruthenium oxide. One objective of this program is to determine the characteristics of the fission products which are released. Analysis of the observed distribution of the various fission products along the wall of the exit-gas tube shows that they are apparently associated with two particle-size groups in the millimicron range in the UO_2 experiments. The distribution of fission products and uranium among the various regions in each experiment is being analyzed and interpreted in terms of the fractionation processes which govern the behavior of these materials. A knowledge of fractionation mechanisms will aid in the recognition of the relative importance of the various factors which define a reactor accident. (auth)

16325 (ORNL-3401(p.35-9)) RELEASE OF FISSION PRODUCTS ON IN-PILE MELTING OF REACTOR FUELS UNDER TRANSIENT REACTOR CONDITIONS. G. W. Parker and R. A. Lorenz (Oak Ridge National Lab., Tenn.).

In preparation for a series of experiments on the release of fission products from UO_2 melted under reactor transient conditions, to be conducted in the TREAT facility at the NRTS, an initial program proposal was reviewed with TREAT management for the purpose of reaching an agreement on the design of the experimental assembly. The proposed experiments will permit the study of fission product release on melting fully clad, 10%-enriched UO_2 in an argon-filled autoclave by means of fast transients of varying magnitude. Provision will be made for preheating the samples to 1200°C and for sampling the released gases and smoke promptly by admission through a filter into an evacuated atuoclave. The fuel specimens in the first experiments in this facility will not be irradiated prior to melting, but specimens having a high degree of burnup will be melted later. Heat transfer determinations and leakage testing of the autoclaves were satisfactorily completed. A hazards analysis is being prepared. (auth)

16326 (ORNL-3401(p.39-43)) FISSION PRODUCT TRANSPORT EVALUATIONS. C. J. Barton, M. E. Davis, and G. W. Parker (Oak Ridge National Lab., Tenn.).

Two methods for determining the heat of vaporization of radioactive species were tested with I^{131}-labeled iodine in the search for a technique to identify the chemical form of fission products released in simulated reactor accident experiments. One method, which depended on the rate of transfer of iodine by helium flowing at a constant rate, gave values for the heat of vaporization of iodine ranging from 13 to 15 kcal/mole. The average value, 14.2 kcal, agreed reasonably well with the literature value of 14.9 for solid iodine. A completely sealed glass system, consisting of two small bulbs connected by a long capillary tube comprised the sample container employed in the second method. The range in concentration of iodine vapor in one bulb, which was in equilibrium with solid or liquid iodine in the other bulb, was measured over a range of temperatures by a crystal detector. Early results obtained by this method varied over a wider range than those obtained by the transport method; however, recent data indicate that this may be a useful technique, and experiments are in progress to obtain a better understanding of iodine behavior in this apparatus. Evidences of adsorption of iodine on glass or quartz walls were observed in both types of experiments. (auth)

16327 (ORNL-3401(p.43-55)) CHARACTERIZATION AND CONTROL OF ACCIDENT-RELEASED FISSION PRODUCTS. W. E. Browning, Jr., R. D. Ackley, et al. (Oak Ridge National Lab., Tenn.).

Two methods for determining the form of radioactivity in gases were investigated. In the first method for characterizing aerosols, diffusion coefficients for fine particles and for radioactive vapors such as iodine are determined by measuring the distribution of radioactivity on the walls of a channel previously exposed to gas carrying radioactive materials and flowing under laminar conditions. This method was applied to the problem of removing millimicron-diameter radioactive particles from air streams. In tests using I^{131}-labeled Al_2O_3 particles with a nominal diameter of 0.004 μ, high-efficiency, low-pressure-drop particulate filters exhibited an efficiency ranging from less than 10% up to about 75%. With activated-carbon beds, 0.75 in. deep and 6 × 16 mesh, iodine vapor removal was essentially complete, but the removal efficiency for 0.003- to 0.006-μ particles was observed to be only 75 to 90%, the higher efficiency being associated with the finer particles. Similar tests were carried out using fog condensation and foam encapsulation to remove millimicron-sized particles from air. In these tests removal efficiencies of 85 to 99% were observed. The second method for measurement of the characteristics of radioactive aerosols makes use of fibrous filters. This method measures aerosols in terms of their response to the processes of inertial impaction, interception, and diffusion under carefully controlled conditions. A filter was developed having uniform fiber diameter to permit theoretical analysis and having a layered structure to facilitate separation of the fiber bed into discrete layers for radioassay after exposure to the aerosol. Preliminary results with a radioactive aerosol of 0.004- to 0.03-μ particles, containing Zn^{65}, indicated that the techniques used are satisfactory and should provide useful information on aerosol character and on filtration mechanisms. (auth)

16328 (ORNL-3401(p.57-60)) NUCLEAR SAFETY PILOT PLANT. M. H. Fontana and L. F. Parsly (Oak Ridge National Lab., Tenn.).

The Nuclear Safety Pilot Plant is an experimental facility to study the release, transport, and removal of fission products in a reactor containment vessel. Design of the installation is virtually complete, with delivery of most of the components scheduled for early in 1963. The outstanding design work is concerned with remote-handling tools and casks for transporting components and samples. Arrangements were made to conduct an experiment in the NSPP cell (prior to the installation of NSPP components) to measure the effectiveness of foam in trapping released activity. This experiment is now in progress using 10 curies of I^{131} dispersed in the atmosphere of the 6000-ft^3 cell. (auth)

16329 (ORNL-3401(p.63-72)) RADIOCHEMICAL-PLANT SAFETY STUDIES. C. E. Guthrie, E. D. Arnold, and J. P. Nichols (Oak Ridge National Lab., Tenn.).

An evaluation was made of the hazards associated with the maximum-credible accidents in a 1-ton/day spent-fuel processing plant. The major conclusions are as follows: (1) As long as the absolute-filter systems retain their 99.97% efficiency, there is negligible hazard if both primary and secondary containment hold, only minor hazard if one of the two containments fails, and a major hazard (contamination of $> 10^5$ m^2) if both containments fail. (2) The hazards associated with an absolute-filter failure are dependent on meteorological conditions. Under the worst conditions (washout) a filter failure could be just as serious (contamination of up to 10^6 m^2) as a failure of both containment systems. Experience at ORNL with degradation of absolute-filter systems in chemical-plant service, in connection with these results, accentuates the vital need to develop a chemically resistant absolute filter. (auth)

16330 (P-1951(RAND)) WEAPONS EFFECTS FOR PROTECTIVE DESIGN. Harold L. Brode (RAND Corp., Santa Monica, Calif.). Mar. 31, 1960. 69p.

A lecture intended to provide a general background in weapons effects is presented. Specific areas of nuclear explosion phenomena pertinent to the design of hardened systems discussed include nuclear radiation and shielding, fireball growth and effects, thermal radiation, air blast, cratering and throwout, ground shock effects, fallout, and afterwinds. (J.R.D.)

16331 (TID-12616(Rev.1)) ATMOSPHERIC RADIOACTIVITY AND FALLOUT RESEARCH. (Division of Biology and Medicine, AEC). Dec. 1962. 95p.

The atmospheric radioactivity and fallout research program of the AEC, Division of Biology and Medicine, is reviewed. This program embraces studies related to radioactive contamination of the environment, including entrance into and effects on man from the release of radioactive material into the atmosphere. The radioactive material may be released into the atmosphere during testing of weapons or from reactors and other devices, such as nuclear-powered rockets. The program includes studies of the characteristics of sources of atmospheric contamination; atmospheric, terrestrial, and aquatic influences on the distribution of contamination; the significance of the material as an external radiation source; the distribution of these materials in the food chain of man; the metabolic behavior of these materials in man and other animals; and the overall effects of these materials in man. The purpose of the program is to gain sufficient understanding of the various physical and biological mechanisms involved in these studies to permit reasonably accurate estimates of the effects on man. (C.H.)

16332 (UCRL-7143) HAZARDS CONTROL QUARTERLY REPORT NO. 10, JULY–SEPTEMBER 1962. (California. Univ., Livermore. Lawrence Radiation Lab.). Contract W-7405-eng-48. 47p.

Work is reported on solid state counting of airborne alpha radioactivity samples. A transistorized neutron monitoring system with remote readout is described. Development of a (γ,n) reaction for differentiation of hydride and deuteride compounds is reported. Use of radioactive NH_4OH aerosols to monitor off-gas cleaning equipment is described. Tests are reported on filters in which it was found that prefiltration does not extend the life of high-efficiency items. A fire-resistant inlet air filter was designed for metal glove boxes. Other activities include installation of a personnel respirator fitting facility, testing of flooring materials for high-explosive handling areas, and coating studies. (J.R.D.)

16333 (AEC-tr-5690) FRAMING OF PRACTICAL RULES FOR SAFETY FROM CONTAMINATION. F. Duhamel and J. M. Lavie. Translated by Helen Basil (Argonne National Lab., Ill.) from p.317-36 of "RISO Symposium, Health Physics in Nuclear Installations," May 25-28, 1959. 25p.

The recommendations of the International Commission for Protection against Radiation regarding maximum permissible concentrations of radioelements in air are used as a basis for the establishment of maximum permissible concentrations for inhalations of short duration. Values for maximum inhalable quantities (M.I.Q.) for various radioelements are compared. (C.H.)

16334 ASSESSMENT OF THE INTERNAL HAZARD. J. Vennart (Radiological Protection Service, Belmont, Surrey, Eng.). Ann. Occupational Hyg., 4: 127-33(Dec. 1961).

The present position regarding the basis for fixing maximum permissible levels of internal contamination are reviewed and the parameters required for the calculation of dose are discussed. Suggestions are made for improving monitoring procedures so that maximum information may be obtained about the risk to which persons are exposed when working in a radioactive environment. There are 2 possible ways of measuring body radioactivity: directly by in vivo observations, or indirectly by a measurement of excreted urine and feces, and in the special cases of radium and thorium, of radon and thoron in the breath. Interpretation of direct measurements is difficult since the precise relation between the amount excreted and the retained burden may be unknown. (P.C.H.)

16335 THE EXTERNAL HAZARD FROM EQUIPMENT GENERATING X RAYS. D. E. Barnes (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Ann. Occupational Hyg., 4: 134-6(Dec. 1961).

The nature, production, and hazards of x radiation are discussed, particularly from the viewpoint of detecting unintentional exposure of personnel operating high-voltage equipment designed to produce x rays or producing them as an incidental by-product of operation. In monitoring areas around x-ray equipment, it should be kept in mind that the energy of the radiation may be lower or higher than the normal range of sensibly uniform response of a survey instrument or personal dosimeter; the output may be pulsed instead of relatively constant (this occurs to some extent with low and medium voltage equipment and is usually marked in high energy equipment; in some cases the pulse duration is only 1 μsec or less); the direction of the useful beam is generally not fixed, but may often be variable over a very wide range of angles and source position. In the choice of survey instruments the ionization chamber is generally best. (P.C.H.)

16336 ON THE HAZARDS OF IONIZING RADIATIONS. C. Kioes. Bull. Soc. Sci. Med. Luxembourg, 98: 147-54 (Mar. 1961). (In French)

16337 ON THE HAZARDS OF IONIZING RADIATIONS. C. E. Rischard and P. Kayser. Bull. Soc. Sci. Med. Luxembourg, 98: 499-503(Oct. 1961). (In French)

A review. (H.H.D.)

16338 RADIOACTIVE LUMINOUS MATERIAL HAZARD R. D. Clubb and T. J. Iltis. Bur. Ships J., 12: 36(Jan. 1963).

Direct radiation of radioactive luminescent material is usually minor, but radioactive particles can be a serious radiation hazard if taken into the body. Less than $^1/_{100}$th of the strontium-90 in 1 type of marker represents the life-

time body limit for this isotope. Damaged or deteriorated luminescent markers or equipment can contaminate local areas with radioactive particles which can circulate in the air or be picked up on the hands or clothing of personnel. Whenever airborne radioactive particles are present, ventilation filters and electrostatic precipitators will collect and concentrate the particles and become radiological hazards themselves. Radium markers, even those without damage, can cause a build-up of airborne particles in the closed atmosphere of submarines through release of the gaseous decay product, radon. Safety precautions are discussed. (APCA Abstr., Vol. VIII, No. 10)

16339 ORTHOPEDIC ASPECTS OF LATE RADIATION INJURY. Guenter Dahmen (Orthopädisches Universitätsklinik, Munster/Westphalia, Ger.). Deut. Med. Wochschr., 87: 1714-16(Aug. 31, 1962).

Twelve case histories relating to children incurring serious, late side-effects of radiodiagnostic or therapeutic procedures are cited. In some cases, the children were irradiated in utero; in others, roentgen therapy was given for benign diseases, such as hemangiomas, warts, arthritis, and neurologic conditions. In 4 children treated with x rays, persistent ulceration of skin or osteomyelitis resulted. In 4 others, bone development was impaired following radiotherapy, and 4 developmental anomalies, possibly attributable to diagnostic radiation exposure during pregnancy, are cited. The human fetus appears to be most radiosensitive, from the point of view of birth defects, during the 1st 45 days of gestation, which includes the stages of implantation and organogenesis. Birth defects observed in a large orthopedic clinic between 1939 and 1961 are described and the possible influence of in utero diagnostic radiation on their incidence is discussed. A general increase in the occurrence of congenital malformations was noted over the period which was accompanied by the increased use of diagnostic x rays. It was concluded that medical irradiation of pregnant women and young children should be avoided whenever possible. (H.H.D.)

16340 A SURVEY OF DENTAL X-RAY MACHINES IN IDAHO. W. O. Young, Howard L. Burkhardt, and Melvin Alsager (Idaho Dept. of Health, Boise). Ind. Med. Surg., 30: 124(Mar. 1961).

Surveys were conducted of 200 machines owned by 194 dentists. The survey consisted of: a visual check of the condition of the machine; determination of whether adequate aluminum filtration and a lead washer were installed; and a check of the condition of the tube housing shielding with a radiation survey meter. The exposures received by the dentist and his assistant while in their normal positions were also measured. Recommended changes in operating technique were: operation at a higher voltage and lower amperage; use of high-speed film; and underexposure and overdevelopment of the film. Before washers and filters were changed it was found that the equivalent filtration in 161 machines was less than 2.5 mm of aluminum, 19 machines had 2.5 mm, and 20 had an unknown amount. Before the program was initiated the beam diameter of 100 machines was 2.75 in.; 71 were larger than 2.75 in., and in 29 cases, unknown. Emulsion rating of film used initially was: 120 dentists used fast, 67 intermediate, 6 slow, and 7 films of unknown speed. The operating kilovoltage varied widely: 11 operated at 50-3 kv, 117 at 65-7, 29 at 70-2, 15 at 80-90, and 18 at an unknown voltage. It was found that 11 machines still in use were manufactured before 1935, 23 were manufactured from 1935 to 1944, 44 from 1955 to 1960, and 20 had an unknown date of manufacture. Although in most instances radiation levels did not approach the maximum allowable limits, it was recommended all unnecessary radiation exposure be eliminated. (H.H.D.)

16341 RADIOBIOLOGY AND SPATIAL NAVIGATION. J.-M. Debois. J. Belge Radiol., 45: 754-66(1962). (In French)

A review on the biological effects of spatial radiations during space flight is presented. (P.C.H.)

16342 VALIDITY OF RADIATION PROTECTION STANDARDS: RE-EVALUATION OF THE RADIUM DIAL PAINTERS. Hyman W. Fisher, Carye-Belle Henle, Robert Bonda, and Lester A. Barrer. J. Med. Soc. New Jersey, 58: 538-41(Nov. 1961).

Clinical and radiation studies were made on all available former dial painters and others exposed to radium. Of the 80 cases studied, 6 died during 1959 and 1960. In laboratory studies, 2 abnormalities were frequent: increased erythrocyte sedimentation rate and nonconsistent alterations in serum globulin patterns. Radiographic and histologic studies of bone (aside from those of the neoplasms mentioned above) revealed multiple bone defects in 21 cases and alterations of trabecular structure in 15 cases. Changes in trabeculae included blurring or destruction, thickening or sclerosis, irregularities in pattern, or coarsening. Periosteal thickening and/or irregularities occurred in 15 cases. Although 18 fracture residua were detected by x rays, only one pathologic fracture was encountered. The most important dental findings were radiographic abnormalities occurring much more frequently in mandible than in maxilla. There is a high incidence of disturbed calcification and disturbed trabecular pattern. (P.C.H.)

16343 CESIUM-137 CONCENTRATION IN HUMAN URINE AND ESTIMATION OF CESIUM-137 BODY BURDEN DUE TO WORLD-WIDE FALLOUT. Masami Izawa and Hiroyuki Tsubota (National Inst. of Radiological Sciences, Chiba, Japan). J. Radiation Res. (Japan), 3: 120-9(June 1962). (In English)

Cesium-137 concentration in human urine was surveyed in Osaka and Ishikawa Prefectures since the fall of 1959. From the results of analyses, time variation of Cs^{137} concentration and difference between two sampling sites were discussed with respect to the fallout rate. Cs^{137} body burden was estimated from the analytical results by assuming the exponential equation for continuous exposure. In November 1959 the values were 8.4 mμC in Ishikawa and 6.0 mμC in Osaka, respectively; they decreased to 3 mμC in October 1961 in both areas. The values were consistent with the results obtained by other methods. The Cs^{137} gonad dose could be calculated with the values assuming uniform distribution of Cs^{137} in a human body. The gonad dose rate due to internally deposited Cs^{137} at present is about 0.7 mrad/yr; and the gonad dose up to the present is in the range of 5 to 8 mrad. (P.C.H.)

16344 FRACTIONATION PHENOMENA IN HIGHLY RADIOACTIVE FALL-OUT PARTICLES. T. Mamuro, K. Yoshikawa, T. Matsunami, A. Fujita, and T. Azuma (Osaka Prefecture, Japan). Nature, 197: 964-6(Mar. 9, 1963).

Highly radioactive fallout particles were found throughout Japan following the series of large-scale nuclear test explosions carried out by the U.S.S.R. during Sept. and Oct., 1961. The radiochemical composition of these particles was determined by γ-ray spectrometry. The composition of large particles was different from that of smaller particles. The extent of the fractionation effect

on the composition of fallout particles was investigated. Data are presented on fractionation factors and fractionation observed in rain water samples collected in Nov. 1961. (C.H.)

16345 AN IRRADIATION CUBICLE: A CONTRIBUTION TO THE IMPROVEMENT OF RADIATION PROTECTION TO NURSING PERSONNEL AND FELLOW PATIENTS BEING TREATED WITH GAMMA EMITTERS. W. Alberti (Hospital of Cheb, Czechoslovakia). Neoplasma, 8: 609-17(1961). (In German)

It is calculated that nurses and patients adjacent to hospitalized persons bearing implanted radioisotopes, such as Ra, Co^{60}, and Cs^{137}, often receive daily doses of radiation exceeding by several fold the minimum dose of 17 Mr/day. To prevent this exposure a bedside concrete shield was constructed that allows the patient to be attended by hospital personnel but reduces the exposure of most of their body by a factor of 50. The cubicle is located in the corner of walls of concrete, and the concrete shield, placed on the other side of the bed, is 100 cm high and 50 cm thick. The upper portion of the shield curves convexly toward the bed so that only the head of the attendant is not protected by the shield. It is estimated that less than 1 to 2.5% of the gamma radiation from Ra or Co^{60} and less than 0.5% from Cs^{137} would not be absorbed by this shield. (H.H.D.)

16346 STUDIES ON RADIOACTIVE CONTAMINATION IN DIFFERENT ORGANS OF HUMAN BEINGS DUE TO GROWING INCREMENT OF RADIOACTIVE FALL-OUT. T. Iwasaki (Niigata Univ., Japan). Niigata Igakkai Zasshi, 75: 987-1004(1961).

Changes in radioactive contamination of organs from June 1956 to Feb. 1958 are described. Radioactive contamination showed a gradual increase during this period, expressed as cpm/g. The increase was greatest in the gonads (testes and ovaries) followed by spleen, lungs, kidneys, and liver. In pathological organs radioactivity was usually weaker than in corresponding healthy organs, except that radioactivity was higher in pathological than in normal kidneys. In children the ribs showed the highest increase in radioactivity; in adults the lungs and the liver; and in old people the kidneys. Radioactivity in the lungs and liver showed a greater increase in out-door than in in-door workers. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

16347 USE AND ABUSE OF X-RAY THERAPY FOR BENIGN SKIN CONDITIONS, WITH PARTICULAR REFERENCE TO X-RAY ATROPHY. Donald M. Pillsbury (Univ. of Pennsylvania, Philadelphia). Postgrad. Med., 30: 180-7 (Sept. 1961).

The effectiveness of x-ray therapy in various skin diseases and its potentialities in the production of skin cancer are discussed. It is proposed that 500 r is the maximum safe total dose of ionizing radiation (with a half-value layer of 1.0 to 2.0 mm of aluminum) which should be given to the skin in the treatment of a benign dermatosis. It is also suggested that very soft irradiation in the so-called grenz range will produce fully as good results in many superficial inflammatory dermatoses as will standard superficial x rays and with far less risk of undesirable late sequelae. Several case histories and photographs are provided to illustrate examples of late x-ray atrophy following the treatment of various dermatoses. Evidence in these cases indicates that the total cumulative dose was of an order considerably in excess of 1000 r, and probably well over 2000 r. It was concluded that x-ray atrophy of the skin following treatment of benign dermatoses is the most completely preventable of all serious human diseases; it is predominantly iatrogenic but to some extent "quackogenic." X-ray atrophy of the skin represents an irretrievable acceleration toward tissue death; it may be slowed by various precautions but it is never reversed. Skin atrophied by x ray is highly vulnerable; its defensive capacity against all types of physical and chemical agents is severely reduced. Preventive and therapeutic measures applicable to radioinduced skin atrophy are outlined, and a list of benign conditions is provided for which radiotherapy is contraindicated. (P.C.H.)

16348 EXPOSURE RATES AND PROTECTIVE MEASURES AGAINST RADIATION. Shields Warren (New England Deaconess Hospital, Boston). Proc. Am. Phil. Soc., 107: 18-20(Feb. 1963).

A review on radiation exposure in excess of background and protective measures against radiation is presented. (P.C.H.)

16349 SAFETY PRECAUTIONS IN DENTAL RADIOGRAPHY. G. R. Seward. Proc. Roy. Soc. Med., 54: 801-8 (Sept. 1961).

Various possible measures for reducing radiation doses in dentistry are presented. Discussion is given on diameter of the primary beam, focus-skin distance, kilovoltage peak and filtration, speed of film, clinical aspects of radiography, technique and the training of operators, gonadal shields, and the x-ray machine. Equipment for limiting beam size must be simple and must require the minimum of adjustment between exposures. The combination of materials to best provide radiopacity together with lightness and strength is a cone built from a cylinder of Perspex and lined with thick lead foil. For a given degree of blackening of the film, the dose to the tissue is reduced by increasing the focus-skin distance, provided the diameter of the beam is adjusted to cover a similar area. A second effect of increasing the focus-skin distance is to reduce the degree of divergence of the beam. Increasing the kilovoltage is one of the most efficient ways of reducing exposure times with dental x-ray machines since for every rise of 10 kv the exposure may be reduced by approximately one-half. For dental radiographs, kilovoltages in the range 60 to 85 are the most acceptable. However, x rays should not be used for diagnostic purposes until other methods have been used. (P.C.H.)

16350 DETERMINATION OF INTEGRAL ABSORBED X-RAY DOSES IN ANIMALS. V. V. Kholin, V. P. Luk'yanov, and A. M. Barkova (Graduate School of Medicine, Leningrad). Radiobiologiya, 2: 947-9(1962). (In Russian)

A calculational method is suggested for determining the integral absorbed dose under various irradiation conditions. A case in which 2 rats (one immature and the other 30 days old) were irradiated with 1000 r at 180 kw, one with 0.5 mm Cu + 1 mm Al filter and $\Delta_{\frac{1}{2}}$ = 1.1 mm Cu and the other where the filter is absent and the $\Delta_{\frac{1}{2}}$ = 0.25 mm Cu, is analyzed. The results showed the absorbed dose for the immature rat was 514,000 g · r and for the 30-day-old rat 123,000 g · r. (R.V.J.)

16351 RADIATION: INDUSTRY'S BEST UNDERSTOOD PROBLEM. J. A. Quigley. Southern Med. J., 54: 1277-82 (Nov. 1961).

Various aspects of detecting and reducing occupational radiation exposure are discussed, with particular reference to the uranium-processing industry. The health problems associated with the processing of uranium for reactors involve 4 basic problems: external radiation; internal emitters (airborne radioactive material or ingested material); chemical hazards; and other hazards. The maximum permissible dose for external penetrating radiation is 5 rad/yr; from uranium

mines through all the processing plants up to the production of reactor fuel elements, there are no serious difficulties in operating at or below this dose for external penetrating radiation. The maximum permissible dose for soft or relatively nonpenetrating radiation is 30 rad/yr, which does not present a serious problem in the uranium industry. For internal emitters maximum allowable concentrations have also been established for breathing air. However, control of airborne radioactive material is the most serious problem. Other health problems encountered in uranium processing include those involving thermal heat, high-voltage electricity, handling of high-density materials, caustics, and pyrophoricity of the metal. (P.C.H.)

16352 PROBLEMS RAISED BY THE STORAGE OF RADIOACTIVE SUBSTANCES. A. Dutreix. Techn. Hosp. (Paris), 18: Suppl., 13-6(Nov. 1961).

16353 VOPROSY DOSIMETRII I ZASHCHITY OT IZLUCHENII. (Dosimetry and Radiation Protection). V. I. Ivanova. Moscow, Gosatomizdat, 1962. 156p.

Twenty-two articles are presented on dosimetry and radiation protection. Characteristics of γ and neutron fields are discussed, and calculated γ constants for 243 isotopes are tabulated. The performance of scintillation γ dosimeters, mixed γ-neutron proportional counters, iron-free beta spectrometers, and β-γ coincidence spectrometers is analyzed. (R.V.J.)

16354 TRANSPORTIROVANIE RADIOAKTIVNYKH VESHCHESTV. (Transportation of Radioactive Materials). N. I. Leshchinskii. Moscow, Gosatomizdat, 1962. 195p.

Regulations for safe transportation of radioactive materials in the Soviet Union are discussed, and charts of maximum permissible air contamination, protective monitoring procedures, and signs specifying the danger are included. (R.V.J.)

16355 IMPROVEMENTS IN AND RELATING TO CONTAINERS FOR RADIO ACTIVE ISOTOPES. (to Hermann Charles Pontet). British Patent 919,643. Feb. 27, 1963. Filed July 28, 1959.

A container is provided composed of two parts so mounted that when in closed position they provide a perfect ray-proof housing but when separated into open position present the isotope for use. (C.E.S.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

Refer also to abstract 15558.

16356 (ARF-1207-9) RESEARCH ON NEW METHODS OF PREPARING HIGH SPECIFIC ACTIVITY RADIOISOTOPES. Quarterly Progress Report No. 3, September 1, 1962–November 31, 1962. P. Y. Feng (Illinois Inst., of Tech., Chicago. Armour Research Foundation). Jan. 9, 1963. Contract AT(11-1)-578. 8p.

Efforts during the period were directed principally toward preparation of high specific activity Co^{60} by means of the hot-atom cation de-fixation process. Chemical elution and electrolytic selective extraction methods were used in separation of Co^{60} nuclei. Tabulated data show an enrichment factor of 7.3 for the first elution-extracted fraction. Results of initial electrolytic extractions were low, and later data suggest that a combined electrolytic-chemical procedure may be the best approach. (J.R.D.)

16357 (HW-76323) RADIOISOTOPIC HEAT SOURCES. C. A. Rohrmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 1, 1963. Contract AT(45-1)-1350. 53p.

Studies were made of radioisotopic heat sources to review the properties of candidate materials, outline the characteristics which determine the feasibility of the production and use of a candidate, identify isotopes which fit the needed characteristics, and thus expand the list of candidate isotopes. A further objective is to provide data that clearly show those isotopes which justify most intensive consideration for production or further research and development for use as heat sources. There are about 50 radioisotopes with half lives of one to one hundred years. These represent about 40 elements and comprise essentially all isotopes which are considered most useful as heat sources. Nine are fission products. The others either occur in nature, were detected in residues from accelerator experiments, or may be produced by neutron irradiation. However, if reasonable restraints are used as bases for selection of these materials, the list of suitable candidates is reduced to eight. These eight are: Co^{60}, Sr^{90}, Cs^{137}, Pm^{147}, Th^{228}, U^{232}, Pu^{238}, and Cm^{244}. Aside from the half life, the most significant restraint which limits the selection is the need for a realistic production process. Economical use of other than thermal reactor neutron irradiation processes which are necessary for the production of certain of these materials does not appear to be attainable soon. Furthermore, the requirement for an isotopic separation process for either target or product also excludes a large number of otherwise attractive materials. Prospects for the development of economical isotope separations processes for intensely radioactive isotopes at a multigram level within the next decade are not encouraging. The wide variation in properties which are significant for heat source uses complicates the problem of logical selection. Those materials finding use today are those which either are at hand or are obtainable by fairly straightforward, though costly, methods. This study indicated that, in comparison with Pu^{238}, Pm^{147} should be receiving more attention. These two are the only candidates on hand with which shielding is a minor problem. Also, U^{232} (and its daughter, Th^{228}) continues to show outstanding characteristics. For the presently available materials, Sr^{90} and Cs^{137} appear to be the least expensive on a cost per watt basis. In some applications, Co^{60} may also be justified economically. Although Cm^{244} can be considered to be available today via special irradiation of plutonium, it may be expected to be obtainable as a byproduct from the processing of highly exposed plutonium, which was recycled as a fuel in thermal reactors. At that time its cost on a heat basis should be significantly less than that of Pu^{238}. (auth)

16358 (JEN-73-SI/18) APLICACIONES DE LOS ISOTOPOS RADIACTIVOS EN LA INDUSTRIA. (Uses of Radioactive Isotopes in Industry). A. Plata, M. del Val Cob, and J. M. Gamboya (Spain. Junta de Energia Nuclear, Madrid). 1962. 32p.

A list of some of the most important problems in industry that were approached by the use of radioactive isotopes is presented. The list was compiled through the experience gained in revising for several years important scientific journals and other sources of information on this subject. The classification of industries was done in an arbitrary way, choosing those isotope uses that have reached a higher degree of development. (auth)

16359 (NP-12596) ON THE NUTRITIVE VALUE OF THE MAJOR NUTRIENTS OF IRRADIATED FOODS AND APPRAISAL OF THE TOXICITY OF IRRADIATED FOODS. Progress Report No. 22, March 1, 1962–September 1, 1962. Roberta Bleiler Hill, Sancia Gaetani, and B. Connor Johnson (Illinois. Univ., Urbana). Contract DA-49-007-MD-544. 12p.

Prothrombin times of Macaca mulatta fed irradiated beef increased slightly more than those of controls. The elevated values decreased spontaneously. The feeding of irradiated beef for over 70 days had no detrimental effect on the monkeys. The feeding of irradiated beef produced vitamin K deficiency in rats. Results of tracer studies in rats led to the conclusion that vitamin K deficiency does not affect protein synthesis. (C.H.)

16360 (NP-12597) HEMORRHAGIC SYNDROME IN RATS FED IRRADIATED BEEF. Progress Report No. 6, July 15, 1961–September 1, 1962. E. A. Doisy, Jr. and J. T. Matschiner (Saint Louis Univ. School of Medicine). 23p.

Progress is reported in studies on the hemorrhagic syndrome observed in rats fed irradiated beef. Various fractions of fresh and irradiated beef and other dietary components were assayed for their content of vitamin K. The chick assay method used for the determination of vitamin K is described. Data are included on the vitamin K content of lipid extract from fresh frozen beef. Amino acids were shown to alleviate vitamin K deficiency, the extracted protein from fresh beef was found to be more hemorrhagenic than that of irradiated beef, and the lipid extract from fresh frozen beef was found to have more vitamin K activity than that from irradiated beef. Squalene, vitamin A, and vitamin A acid were shown to produce effects in the chick similar to those in the rat. Results of preliminary studies in rats indicate that the mechanism of anticoagulant action of squalene may be in the bowel. (C.H.)

16361 (NP-12598) THE EFFECT OF CONTROL-GROUND BEEF AND IRRADIATED 5.58 MEGARAD-GROUND BEEF CONSUMPTION ON REPRODUCTIVE PERFORMANCE IN THE BEAGLE. Progress Report No. 5, March 15, 1962–September 15, 1962. Thomas B. Clarkson and James R. Pick (Wake Forest Coll., Winston-Salem, N. C. Bowman Gray School of Medicine). Contract DA-49-193-MD-209A. 5p.

No differences in reproductive performance were observed in control groups and in beagles maintained on a diet that included 35% irradiated ground beef. (C.H.)

16362 (NP-12599) CAROTENE BIOPOTENCY IN RATIONS CONTAINING GAMMA-IRRADIATED CARROTS AND LIVER CYTOCHROME OXIDASE AND INGESTION OF IRRADIATED MEAT. Progress Report, April 15, 1962–September 15, 1962. Report No. 2. Ian J. Tinsley (Oregon. Agricultural Experiment Station, Corvallis). Contract DA-MD-49-193-62-642. 5p.

The ingestion of irradiated carrots for a period of 10 weeks resulted in lowered liver levels of vitamin A and the long-term feeding of irradiated carrots resulted in depressed growth rate in rats. An increase in liver cytochrome oxidase was observed in rats fed irradiated pork for 8 weeks. Preliminary results are included from experiments designed to correlate cytochrome oxidase activity with the mitochondrial lipid composition of rats raised on irradiated pork rations and rats raised on rations containing various proportions of coconut oil and oleic acid. (C.H.)

16363 (NP-12600) FEEDING OF DOGS, RABBITS AND HAMSTERS WITH IRRADIATED SHRIMP AND ITS EFFECT UPON THYROID ACTIVITY (PHASE 1). EFFECT ON RESISTANCE TO INFECTION (PHASE 2). Progress Report No. 9, Six Months Period Ending September 15, 1962. D. F. Watson, R. M. Smibert, K. G. Libke, and R. W. Engel (Virginia. Agricultural Experiment Station, Blacksburg). 10p.

Dogs and rats were fed a diet that contained fresh frozen shrimp, frozen shrimp held in storage for a minimum of 3 yr, radiation-processed shrimp held in storage for 3 to 5 yr, or recently irradiated shrimp held at 70 to 80°F for two months prior to use. Dogs maintained on a diet of old, radiation-processed shrimp for about 30 days showed abnormal thyroid activity. No conclusions were drawn as to the age of the shrimp as a factor in the thyroid abnormality. Hematologic, reproductive and pathologic data on the experimental animals are included. (C.H.)

16364 (NP-12602) TO DETERMINE THE EFFECT OF IRRADIATION UPON THE WHOLESOMENESS OF FOOD. Progress Report No. 14, March–September 1962. Elwood F. Reber, Om P. Malhotra, and Horace W. Norton (Illinois. Univ., Urbana. Coll. of Veterinary Medicine and Illinois. Agricultural Experiment Station, Urbana). Contract DA-49-007-MD-72800. 128p.

Thesis by Om Parkash Malhotra submitted to Univ. of Illinois, Urbana.

Rations containing 35% irradiated beef caused spontaneous hemorrhages and subsequent death in male rats. Results are presented from a study of the effects of estrogen, testosterone, vitamin K, methionine, and strain of rat on the incidence of hemorrhagic disease, blood coagulation, and prothrombin times of plasma samples. The data suggest a probable interaction between vitamin K and methionine, but it was concluded that methionine destruction in irradiated beef was not the cause of hemorrhagic diathesis in rats fed the hemorrhagenic ration. (C.H.)

16365 (NP-12603) SUMMARY OF SIGNIFICANT FINDINGS BY SGO CONTRACTORS. Report Period: March–September 1962. Nicholas Raica, Jr. and Howerde E. Sauberlich (Army Medical Research and Nutrition Lab., Denver). Feb. 11, 1963. 3p.

The ingestion of irradiated beef and shrimp produced no histopathologic changes that could be attributed to the foods or level of irradiation in dogs, rats, mice, or monkeys. Results are summarized from studies on vitamin K and protein synthesis in animals on the experimental diet, the effects of estrogen, testosterone, or methionine on the incidence of hemorrhagic disease in rats, and carbonyl formation in irradiated meats. (C.H.)

16366 (NP-12604) PORK DIET—REPORT OF OBSERVATIONS [ON] NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR OREGON STATE UNIVERSITY, CORVALLIS, OREGON. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1962. 26p.

The consumption of a diet containing irradiated pork caused no specific histologic changes in rats. Data are presented on the incidence of pathologic lesions in control and experimental animals. (C.H.)

16367 (NP-12605) CARROT DIET—REPORT OF OBSERVATIONS [ON] NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR OREGON STATE UNIVERSITY, CORVALLIS, OREGON. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1962. 39p.

The consumption of irradiated carrots produced no histopathologic changes in rats that could be attributed to carrots. (C.H.)

16368 (NP-12606) DOG FEEDING STUDIES—REPORT OF OBSERVATIONS [ON] NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR VANDERBILT SCHOOL OF MEDICINE, NASHVILLE, TENNESSEE. W. E. Tucker, Jr. (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1962. 8p.

The consumption of irradiated chicken, ground beef, or pineapple jam did not produce any histopathologic change in dogs that can be attributed to the foods or to the level of irradiation. (C.H.)

16369 (NP-12607) REPORT OF OBSERVATIONS [ON] NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR DEPARTMENT OF FOOD TECHNOLOGY, MASSACHUSETTS INSTITUTE OF TECHNOLOGY, CAMBRIDGE, MASSACHUSETTS. W. E. Tucker, Jr. (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1962. 4p.

The ingestion of irradiated dried whole eggs produced no histopathologic change in dogs that could be attributed to the food or to the level of irradiation. (C.H.)

16370 (NP-12608) DOG FEEDING STUDIES—REPORT OF OBSERVATIONS [ON] NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR DEPARTMENT OF ANIMAL HUSBANDRY, CORNELL UNIVERSITY, ITHACA, NEW YORK. W. E. Tucker, Jr. (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1962. 4p.

The consumption of irradiated potatoes by dogs did not produce any histopathologic changes that can be attributed to the food or to the level of irradiation. (C.H.)

16371 (NP-12609) WHOLE ORANGE DIET—REPORT OF OBSERVATIONS [ON] NUTRITION: RADIATION AND STERILIZATION OF FOODS FOR SYRACUSE UNIVERSITY, SYRACUSE, NEW YORK. M. A. Ross (Armed Forces Inst. of Pathology, Washington, D. C.). Sept. 15, 1962. 39p.

No pathologic changes attributable to diet were noted in rats fed whole irradiated oranges. (C.H.)

16372 (TID-18124) A SEDIMENT DENSITY METER. R. A. Hodgson, C. G. Denny, and Ralph Monaghan (Dresser Research. Div. of Dresser Industries, Inc., Tulsa, Okla.). Nov. 1962. Contract AT(40-1)-2969. 28p.

A sediment density meter using scattered γ rays was designed to facilitate the measurement of sedimentation on the bottoms of oceans, lakes, and rivers. Desirable features include the accurate determination of sediment density in the range 1.2 g/cm^3 to 1.5 g/cm^3, measurement of these densities without tedious and time consuming mechanical sampling, a measurement of the sediment layer into which the instrument is dropped, and the recording and storage of data in the instrument until brought to the surface. This instrument increases the speed of operation and improves the quality of data obtained. The laboratory prototype instrument operated well during the mechanical test. (H.G.G.)

16373 DRAFT RESEARCH ON FOOD PRESERVATION BY IRRADIATION IN POLAND. E. Pijanowrki (Warsaw Agricultural Univ.). Food Irradiation, 3: A2-5(July-Dec. 1962).

Applications of ionizing radiation in food processing in Poland are reviewed. Results are summarized from investigations on the effects of radiation on sprout inhibition in potatoes and onions, the effects of radiation processing on the storage life of blueberries, wild strawberries, and mushrooms, the use of radiation to slow down germination in barley used for making malt and in the treatment of milk for cheesemaking, the effects of radiation on the storage life of beef and pork, and the possibility of breaking down wood cellulose in sawdust to obtain glucides. (C.H.)

16374 LETHAL DOSES OF GAMMA RADIATION OF SOME FRUIT SPOILAGE MICROORGANISMS. G. D. Saravacos, L. P. Hatzipetrou, and E. Georgiadou. Food Irradiation, 3: A6-9(July-Dec. 1962).

The radiation resistance of some yeasts and fungi causing spoilage on certain fruits was determined using radiation from two Co^{60} sources. The destruction of these microörganisms is of great importance in determining the dose to be applied in the radio-pasteurization of fresh fruits. Twelve species of yeasts and 8 species of fungi were isolated from oranges, grapes, and dried figs, and identified according to the standard microbiological procedures. The yeast cells were irradiated in suspension in a buffer solution and their survival was determined by plating in malt-extract-agar. The fungi were irradiated in malt extract agar slants and the irradiated cultures were observed for growth. The minimum lethal radiation doses for yeasts varied between 450,000 Rad (Rhodotorula) and 2,000,000 Rad (Pullularia). The fungi were found to have a lower resistance to radiation which varied between 250,000 Rad (Penicillium) and 600,000 Rad (Alternaria). The yeast-like organism Pullularia pullulans was found to have an exceptionally high resistance to gamma radiation. This organism causes black spots on grapes and oranges and was found to grow on these fruits which has been irradiated at 500,000 Rad. (auth)

16375 IRRADIATION OF FRUITS AND VEGETABLES IN INDIA. P. B. Mathur (Atomic Energy Establishment, Trombay, India). Food Irradiation, 3: A10(July-Dec. 1962).

The nucleus of a group to study the problems relating to food irradiation was established at the Atomic Energy Establishment, Trombay, in 1959. Results are reported from studies on the effects of radiation on sprout inhibition and storage life of potatoes and onions. Other commodities under investigation include guava, sapota, ginger, garlic, kidney beans, and tomatoes. (C.H.)

16376 COBALT-60 IRRADIATION PLANT. Ind. Chemist, 39: 14-15(Jan. 1963).

The first commercial, privately owned irradiation plant is a 50,000-curie Co^{60} plant used by Johnson's Ethical Plastics Ltd. to sterilize disposable plastic hypodermic syringes. The plant is described briefly. The total exposure time is 3.5 days. (D.L.C.)

16377 NEW PROGRESS USING RADIOISOTOPES IN THE STUDY OF WEAR DUE TO FRICTION. Cheng-lieh Liu. K'o Hsueh T'ung Pao, No. 11, 30-3(1961).

In the study of wear resulting from friction, the use of radioisotopes has the advantage of being accurate, convenient, rapid, and economical. Feasibility of the method lies in irradiation of the machine parts and detection of radioactivity in the abraded metal particles. Machine parts may be irradiated with radioisotopes in a reactor or in a cyclotron, by surface irradiation in electroplating, or irradiation by casting, embedding of radioactive materials, or surface diffusion. Isotopes Tl^{204}, Co^{60}, W^{187}, Sb^{124}, Ag^{110}, Zn^{65}, S^{35}, P^{30}, Fe^{59}, and In^{114} may be used. Radioactivity of abraded metal particles in the lubricating oil is measured by a Geiger or scintillation counter to determine the rate of wear. Radioisotopes can also be used to investigate the limits of wear, physical and chemical properties of machine tools, and quality of lubricating oil. (P.C.H.)

16378 RADIOISOTOPES—THEIR VARIED USES. Robert E. Wilson. Nucl. Energy, 73-7(Mar. 1963).

A general discussion is given of the AEC's activities in the field of radioisotopes. The extent of AEC policy and the participation of industry in this field are discussed. The various applications of radioisotopes are reviewed briefly. (D.L.C.)

16379 POLAROGRAPHIC STUDIES ON STORAGE OF MEATS. PART XIX. INFLUENCE OF GAMMA-RAY IRRADIATION ON PROTEIN WAVE OF RABBIT TROPOMYOSIN. Tetsujiro Obara and Yasokichi Ogasawara (Tokyo Univ.). Radioisotopes (Tokyo), 11: 283-92(Aug. 1962). (In Japanese)

The effects of 21-day storage of irradiated (up to 7 Mr) and unirradiated rabbit tropomyosin at 15°C are studied. It is found that the protein wave of the irradiated samples is constant in time, while that of the unirradiated samples changes with time. It is concluded that the 15°C storage affects the unirradiated samples, but not the irradiated samples. (T.F.H.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstracts 16880, 16899, 16900, 16901, 16904, and 16905.

16380 (AERE-R-4186) THE CONSTRUCTION AND CALIBRATION OF A VARIABLE TEMPERATURE GOUY MAGNETIC SUSCEPTIBILITY APPARATUS. R. Colton (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1963. 22p.

An apparatus was constructed to measure magnetic susceptibilities by the Gouy method over a wide temperature range. The cryostat is controlled electrically and required temperatures are attained by balancing the cooling effect of liquid nitrogen against the heating effect of a coil. The temperature range runs from 77 to ~ 350°K and is measured with a calibrated thermocouple. A large electromagnet produces a field of greater than 6000 gauss and the force on the sample in the field is measured by a conventional semi-microbalance. Details of the magnetic field and thermocouple calibrations are given. (auth)

16381 (CEA-1932) AMPLIFICATEURS D'IMPULSIONS A TRANSISTORS (A.I.T.). (Transistorized Pulse Amplifiers (A.I.T.)). Jean Feyt and J. Pierre Couly (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 19p.

The two amplifiers whose design and operation are described were studied for neutron detection units used in piles. They are designed to allow an important reduction of the volume and of the weight of the detector and its amplifier, and to simplify the operation of the detection assembly. To these characteristics can be added the mechanical and electrical robustness and the very reduced microphony. The first transistorized amplifier is simple, robust, and can be used for radio-protection installations. The second has a better performance. (auth)

16382 (IDO-16823) THE TUNNEL DIODE AS A FAST DISCRIMINATING SWITCH. Clayton S. Miller (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 5, 1962. Contract AT(10-1)-205. 8p.

The application of tunnel diode discriminators to high pulse rate counting circuitry imposes special requirements on the associated counting apparatus. Some circuit modifications are discussed which are desirable for the use of tunnel diode discriminators to accept high level data pulses in the presence of a high rate of low level background pulse (i.e., to prevent pulse "pile-up"), and in another application to discriminate against low level pulses in the presence of a high rate of data pulses (i.e., discrimination without significant loss of resolving time). (auth)

16383 (JUL-88-PP) A SLIDING SPARK WITH LOW INDUCTANCE AS A LIGHT SOURCE FOR THE VACUUM ULTRAVIOLET. H. Conrads (Kernforschungsanlage. Institut für Plasmaphysik, Jülich, Germany). Dec. 1962. 32p.

A low inductance sliding spark was developed as a light source for vacuum ultraviolet operation (50 Å < λ < 2000 Å). Compared with Millikan's spark, a low breakdown voltage is obtained. A reproducible, intense line radiation was observed at a lower limit of 65 Å. The main part of the line spectrum was emitted from the insulator disk separating the electrodes. From strong line radiation of Al VII the electron temperature of the sliding spark was estimated to be approximately $2 \cdot 10^5$°K using Saha's and Boltzmann's formulas. (auth)

16384 (LADC-5679) SOME MEASUREMENT PROBLEMS ENCOUNTERED IN A NUCLEAR ROCKET ENVIRONMENT. Dwight L. Stephenson (Los Alamos Scientific Lab., N. Mex.). [nd]. Contract [W-7405-eng-36]. 12p.

Instrumentation development for nuclear rockets is discussed. The Kiwi reactor and some of its parameters that must be measured are described. Measurements that are required fall into 3 categories: propellant storage, propellant feed system, and reactor diagnostics. The environment for nuclear rocket instrumentation, including thermal, acoustic, and radiation aspects, is discussed. Transducer development is described. (M.C.G.)

16385 (NP-12457) SPECTROMETRE DE MASSE DU LABORATOIRE DE GÉOLOGIE ET GEÖCHIMIE NUCLÉAIRES. (Mass Spectrometer of the Laboratoire de Géologie et Géochimie Nucléaires). M. Reinharz, R. Delwiche, and J. Katz (Brussels. Universite). Oct. 1962. 59p.

The design, characteristics, performance, and typical measurements of the mass spectrometer constructed at the Laboratoire de Geologie et Geochimie Nucleaires are described. As an introduction the principle of isotope separation, functioning of a mass spectrometer, and different types of mass spectrometers are discussed. (J.S.R.)

16386 (TID-18162) DEVELOPMENT LEADING TO AN IMPROVED DENSITOMETER FOR HELIUM-GRAPHITE OR NITROGEN-GRAPHITE FLOW STREAMS. Quarterly Report No. 189-12, August–October 1962. Donald H. Strobel (Badger Meter Mfg. Co., Milwaukee). Feb. 6, 1963. Contract AT(11-1)-1111. 29p.

A progress report on the development of an instrument for measuring the density of helium–graphite and nitrogen-graphite flow streams is presented. The density meter is a closed loop servo system using radioactive isotopes for the density sensing transducers. The calibration of the system is independent of isotope decay, detector gain changes, servo component gain changes, ambient nuclear radiation, or radiation present in the flow stream. Design parameters included operating temperatures to 600°F, pressures to 250 psi, flow stream velocities of 50 to 250 ft/sec, and graphite particle size of one to 2 μ. Preliminary testing indicates that modifications to the electronics will be necessary to improve the signal to noise ratio of the system. Drift rates were excessive (±10%) and repeatability was <±5%. Estimated percentage of completion is 73%. (H.G.G.)

16387 FOCUSING OF CHARGED PARTICLES IN A CYLINDRICALLY SYMMETRIC MAGNETIC FIELD PROPORTIONAL TO r^{-1}. G. E. Lee-Whiting (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 41: 496-532(Mar. 1963).

The aberrations associated with skew trajectories lying near the midplane of a "flat"-type β spectrometer with a magnetic field falling off as r^{-1} were surveyed over wide ranges of values of the field strength at the source and of the angle of emission; Lafoucrière showed that such a field

possesses a perfect focus for midplanar orbits. A field strength was found for which the aberrations corresponding to finite aperture are exceedingly small; with a point source it would be possible to get transmissions of 2.3% and 6.0% at resolutions of 0.01% and 0.1% respectively. The defocusing resulting from finite source-height was studied for this particular value of the field strength and was found to be large; the resulting permissible source-area is so small that the luminosity of the instrument is inferior to that of a $r\sqrt{2}$ spectrometer. Methods of producing fields varying as r^{-1} over a wide range of r were investigated; both iron pole-pieces and iron-free coils were considered. (auth)

16388 INTENSIVE DEVELOPMENT IN NUCLEAR INSTRUMENTATION IN GREAT BRITAIN. E. N. Shaw. Europa Nucl., 6: 62-6(Jan.-Feb. 1963). (In English) (Also in Italian; French; and German)

A review is presented of the status, developments, and trends in the British nuclear instruments industry. Among the developed instruments discussed are unit systems, amplifiers, laboratory counting instruments, personnel monitoring equipment, rapid assay equipment, radiation scanners, and neutron generators. (D.L.C.)

16389 THE DISTANT GEOMAGNETIC FIELD. 2. MODULATION OF A SPINNING COIL EMF BY MAGNETIC SIGNALS. C. P. Sonett (National Aeronautics and Space Administration, Washington, D. C.). J. Geophys. Res., 68: 1229-32(Mar. 1, 1963).

The modulation of a spinning search coil signal by time-variant magnetic fields is discussed. For typical spacecraft usage, dipolar inhomogeneity produces a trivial signal. The primary contributions to the signal arise from the coil spin and field time variance. Variations in the scalar value of the field produce both amplitude and phase modulation. In a base field like the earth's with superimposed fluctuations, amplitude modulation from Alfvén waves is usually trivial. The amplitude power spectrum depends on both the spin rate of the spacecraft and the Fourier decomposed frequencies of the fluctuations. Where frequencies near the spin are encountered, spectral inversion can result from what becomes effectively the mixing of two carrier signals. The results of the previous paper of this series are discussed under these conditions, the latter of which is essentially removal of the restriction $(\partial H/\partial t \ll \omega H)$. (auth)

16390 A FIVE MHz TRANSISTOR DECADE COUNTER ACCORDING TO ESONE-STANDARDS. H. Klessmann (Hahn-Meitner-Institut für Kernforschung, Berlin). Kerntechnik, 5: 9-12(Jan. 1963). (In German)

A description is given of the design, performance, and construction of a low-cost transistorized counter decade, based on binary circuits, which accepts a maximum counting rate of 5 MHz. The printed-circuit dimensions, voltages, and electrical signals of this transistor decade are according to ESONE-Standards (European Standards of Nuclear Electronics). The circuit requires positive input signals of ≧ 4 volts amplitude and operates reliably at temperatures from −10 to +60°C with collector supply voltage varying from 5 to 7 volts. The scale of sixteen is converted into the scale of ten by means of an "and" gate only. Normal direct pulse feedback is avoided and the resolution time is largely determined by the first binary. Four line 1-2-4-8-coded output for visual read-out and gated outputs for print-out are provided. (auth)

16391 LOGARITHMIC INTEGRATOR TYPE ILG-1 AND ILG-2. Leslaw Gąsiorowski, Stefan Urbański, and Henryk Wawrzyszczuk (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 7: 655-7 (1962). (In Polish)

The integrator measures the average count rate in the range 10 to 100,000 impulses per second to an accuracy of better than 10%, has a drift of less than 10% per day, and the output departs from true logarithmic by less than 5%. The logarithmic integrator circuitry includes a preamplifier, discriminator, pulse shaping network, and a set of seven diode pumps. Each diode has its individual R-C time constant and the seven diodes thus span the four decades of count rate. An additional feature of the integrator is a 10,000 cycle quartz oscillator used for calibration of the instrument (at one point on the curve; 10,000 impulses per second). The ILG-1 has an output of 15 V/decade. The ILG-2 is operationally identical except that its output is 6 V/decade, and it is designed for manufacture in large numbers. (TTT)

16392 ONE-CHANNEL AMPLITUDE ANALYZER. Jerzy Chmielewski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nukleonika, 7: 657-60 (1962). (In Polish)

A conventional single-channel analyzer is described. The analyzer embodies a delay circuit that sends out a pulse 4 to 10 microseconds after the analyzer pulse. The delay circuit operates on a pulse taken from the input of the analyzer. This pulse is buffered with a cathode follower which sends it to trigger a delay generator. The trigger level is set to accept very small pulses. The output of the delay generator is sent to a flip-flop (bistable) circuit. If the analyzer circuit had been triggered by this same input pulse, then it would have switched the flip-flop circuit from the "O" position to the "I" position. In only this case can the output of the delay generator switch the flip-flop circuit. It switches it back to the "O" position. This polarity of switching (flopping) produces a delayed output pulse in a pulse shaping circuit that follows the flip-flop. Thus, an output pulse is produced only when the analyzer also produces a pulse. This output pulse has a fixed delay (variable from 4 to 10 microseconds) that is reasonably independent of the size of the input pulse and the analyzer level. This delayed pulse is available from a separate output. The analyzer proper can be used in either the "single-channel" or the "discriminator" mode. In the latest version of the analyzer, its level can be varied in steps of 1 volt in the range of 5 to 100 volts. The window width is also variable in discrete steps. These are 0, 0.5, 1, 2, 3, 5, and 10 volt window widths. (TTT)

16393 METHOD FOR RECORDING RADIATION SPECTRA OF THE PULSE DISCHARGE WITH TIME RESOLUTION OF 10^{-9} SEC. S. I. Andreev, M. P. Vanyukov, and E. V. Daniel. Opt. Spectry. (USSR) (English Transl.), 13: 492-3(Dec. 1962).

A simple device for photographing time-resolved spark discharge spectra with a time resolution of at least 20 nsec utilizes a Kerr shutter triggered by nsec high-voltage pulses that are generated in synchronism with the start of current flow in the discharge. (D.C.W.)

16394 PHOTO-ELECTRONIC IMAGE DEVICES. Proceedings of the Second Symposium Held at Imperial College, London, September 5-8, 1961. J. D. McGee, W. L. Wilcock, and L. Mandel, eds. Advances in Electronics and Electron Physics. Volume XVI. London, Academic Press Inc., 1962. 667p. $18.50.

Sixty-five papers are presented on a variety of topics in photo-electronic image devices. Some of the devices treated are image tubes, image intensifiers, orthicon tubes,

vidicon tubes, electron tubes, electronic cameras, detectors, etc. (D.L.C.)

16395 IMPROVEMENTS IN OR RELATING TO WELL LOGGING BY NUCLEAR RADIATIONS. (to California Research Corp.). British Patent 921,100. Mar. 13, 1963. Filed Mar. 6, 1959.

An apparatus is designed for neutron-gamma well logging. The gamma detector is surrounded by two shielding means, one of bismuth for shielding against gamma rays from the neutron source and the other of boron for shielding against thermal neutrons scattered from the earth formations. The logging sonde housing is coated with boron to reduce the thermal-neutron gamma rays from iron. (D.L.C.)

16396 IMPROVEMENTS IN OR RELATING TO GAS ANALYSIS APPARATUS. Frank Peter Speakman and Lawrence Williams (to Pye Ltd.). British Patent 921,215. Mar. 13, 1963. Filed July 29, 1958.

An ionization chamber with a radiation source is designed for detecting fluid traces carried by a carrier gas through a chromatographic column. The chamber comprises a hollow body with a cavity and an electrode mounted therein, the electrode being insulated from the body and connected to a high-tension supply source. The supply source is provided with screening means to prevent leakage currents to earth from its output terminals. A d-c amplifier and a resistor are provided for linearizing the output current of the ionization chamber. (D.L.C.)

16397 IMPROVEMENTS IN AND RELATING TO RADIATION GAUGES. (to Industrial Nucleonics Corp.). British Patent 921,397. Mar. 20, 1963. Priority date, Apr. 14, 1960, United States.

A beta radiation gage for measuring mass and thickness of a material is designed which is insensitive to changes in the atomic constituents of the material. The detector is responsive both to the transmitted beta rays and to the generated x rays, and means is provided for adjusting the relative magnitudes of the beta and x rays so that a decrease in beta rays due to change in composition is cancelled by the increase in x rays. (D.L.C.)

16398 IMPROVEMENTS IN INDICATING OR CONTROLLING DEVICES. Gordon William Whitehurst (to Simon-Carves Ltd.). British Patent 921,476. Mar. 20, 1963. Filed Aug. 17, 1959.

A modified device of the type described in British Patent 868,696, is designed for indicating or controlling the level of a material in a container. The device comprises a radiation source, a scintillation counter, a blocking oscillator-type circuit triggered by the counter pulses, an electromagnetic relay for energizing an indicator or control circuit in response to the oscillator. A variable resistor is provided for adjusting the device sensitivity. (D.L.C.)

16399 RADIATION METHOD AND APPARATUS FOR CONTINUOUSLY MEASURING THE MASS PER UNIT AREA OF A COATING. Norman Z. Alcock (to Canadian Curtiss-Wright, Ltd.). Canadian Patent 651,597. Nov. 6, 1962. Filed May 17, 1955.

A radiation thickness gage for measuring the thickness and variation of thickness of a coating on a sheet is provided. The gage provides for adjustment of the activation of the balancing chamber by means of a movable iris disposed between the source and the chamber. (C.E.S.)

16400 METHOD AND APPARATUS FOR MEASURING THE MASS PER UNIT AREA OF A SUBJECT MATERIAL. Donald C. Brunton and Norman Z. Alcock (to Canadian Curtiss-Wright, Ltd.). Canadian Patent 651,598. Nov. 9, 1962. Filed Jan. 20, 1956.

A radiation thickness gage is provided wherein a single radiation source is employed in conjunction with two detectors. Short lived materials may be employed as a source material since the ratio of source strength to the two detectors will be constant throughout the life of the source. An adjustable iris is placed between the source and one of the detectors. Signals from the detectors define a resulting signal, the alternating current equivalent of which drives a motor that adjusts the iris plate position with respect to a calibrated scale. (C.E.S.)

16401 RADIO ACTIVE METHOD AND APPARATUS FOR DIRECT MEASUREMENT OF MASS PER UNIT AREA. Thomas P. Pepper and Andrew J. Pressesky (to Canadian Curtiss-Wright, Ltd.). Canadian Patent 651,599. Nov. 6, 1962. Filed Feb. 22, 1956.

A radiation thickness gage is described which obviates the need for a comparison standard. A β or γ source is arranged between two ionization chambers in such a way that the radiation passes thru the sample to one chamber and thru an adjustable aperture to the other chamber. The difference signal from these two chambers is used to drive an a-c motor which adjusts the aperture until the difference signal is zero. As the aperture is adjusted a pointer moves on a scale to indicate the relative thickness or density of the sample. (T.R.H.)

16402 MAGNETIC DEMAGNETIZING DEVICES. Georges Bonnet and Roger Gariod (to Commissariat à l'Énergie Atomique). Canadian Patent 653,533. Dec. 4, 1962. Priority date Aug. 30, 1958, France.

A magnetic demagnetizing device consists of a transformer tapping an a-c line connected by an electronic system that effects and regulates a-c power flow to an exit transformer, the secondary of which is coupled to the demagnetizing coil. (D.C.W.)

16403 PRESSURE TRANSFORMER FOR MEASURING THE PRESSURE OF A RADIOACTIVELY CONTAMINATED MEDIUM. W. Stuermer and E. Elssner (to Brown, Boveri and Cie., and Beteiligungs-und Patentverwaltungsges. m.b.H.). German Patent DAS 1,142,710. Jan. 24, 1963. Filed Apr. 28, 1959.

The pressure transformer is composed of two diaphragms that are rigidly connected by a rod. One side of the first diaphragm is in contact with the contaminated reactor coolant medium, the pressure of which is to be measured. In order to prevent leakage of the reactor coolant through the first diaphragm, the other side is enveloped by a gas shielding. The shielding gas is circulated in an auxiliary loop. In this loop the gas enters the pressure transformer through a fixed orifice, and after passing the other side of the first diaphragm it flows via a variable pressure reducing device against the second diaphragm, against the side of the diaphragm that is opposite the first diaphragm, and from there via a fixed pressure reducing device out of the pressure transformer. The gas at the outlet of the fixed pressure reducing device acts upon the outer side of the second diaphragm. Thus it exerts on one face a pressure corresponding to that pressure at the inlet of the fixed pressure reducing device and on the outer face a pressure corresponding to the outlet pressure of the device. The pressure difference between the inlet and the outlet of the fixed pressure reducing device is measured, this pressure difference being proportional to the pressure difference between the contaminated coolant and the shielding gas. (Gmelin Institute)

16404 DEVICE FOR MONITORING BY COMPARING THE RATIO OF TWO CURRENTS TO BE MEASURED. N. Hemmer (to Siemens and Halske, A. G.). German Patent DAS 1,142,945. Jan. 31, 1963. Filed Nov. 21, 1961.

A device is described for monitoring nuclear power plants that consists of two balanced magnetic amplifiers. Two electric signals from two independent safety systems are fed simultaneously but in opposite sense into the two amplifiers, the corresponding windings of the two amplifiers being connected in series. Thus in both amplifiers the difference between the two signals, but with opposite sign, is obtained. In each of the two amplifiers the difference signal is switched against a tolerance signal, the value of which is obtained from at least one of the signals to be measured. The result is that instead of a comparison of the differences of the monitored values with the tolerance value one has a comparison of its ratio with the tolerance value. (Gmelin Institute)

16405 RADIATION FLOWMETER. William P. Staker, Robert B. Jacobs and Irwin Ginsburgh (to Standard Oil Co.). U. S. Patent 3,075,077. Jan. 22, 1963. Filed Mar. 18, 1959.

A method and apparatus were designed for measuring the flow of fluids using very small quantities of radioisotopes with half lives on the order of minutes. A radioisotope is introduced into a conduit confining the fluid stream whose flowrate is to be measured. The emitted radioactivity is detected successively by two or more radiation detectors spaced at known distances along the conduit. The detected pulses of radioactivity are recorded as discrete markings on a permanent record such as a moving strip chart. The permanent record can be analyzed to determine whether the stream is in viscous or turbulent flow in addition to determining the flowrate. The apparatus can also be used to determine the amount of vaporization in a furnace tube. The design of the apparatus is described in detail. (M.P.G.)

16406 CYCLOTRON WAVE PARAMETRIC AMPLIFIER WITH DECREASED MAGNETIC BIAS. Johan W. Kluever (to Bell Telephone Labs., Inc.). U. S. Patent 3,075,154. Jan. 22, 1963. Filed Dec. 29, 1961.

A design for a cyclotron-wave parametric, or quadrupole amplifier is described, in which the magnetic field requirements are reduced without resorting to distributed circuits. The electron beam is given an initial "twist" or uniform rotational velocity component by a magnetically shielded electron gun, which injects the beam into the longitudinal magnetic field in accordance with the principles of Brillouin flow. The rotational velocity of the electron beam gives the unmodulated electrons an inherent periodicity. Synchronism between the signal wave and the beam can be attained, even if the cyclotron frequency is lower than the signal frequency, thereby reducing the magnetic field requirements. The design and variations in the design of the parametric amplifier are described in detail. (M.P.G.)

16407 GAMMA RAY THICKNESS GAUGES. John Laban Putman, Sidney Jefferson, and Richard Bruce Owen (to United Kingdom Atomic Energy Authority). U. S. Patent 3,076,894. Feb. 5, 1963. Priority date June 24, 1953, Great Britain.

A thickness gage operating on the back-scattering principle is described. The thickness of an article, such as the wall of a pipe, can be measured from one face without having access to the other face. A γ-ray source is placed close to the surface of the article whose thickness is to be measured, and a detector, preferably a scintillation counter, is placed directly above the surface with no shielding from the source. A single-channel pulse-amplitude analyzer is adjusted to block most pulses due to direct excitation from the source and to pass to a rate meter pulses derived from γ-rays back-scattered from the surface. The amplitude of the pulses fed to the rate meter may be adjusted to compensate for variations in the strength of the source. (M.P.G.)

16408 METHOD FOR GAMMA RAY SPECTRAL ANALYSIS. Ralph Monaghan (to Well Surveys, Inc.). U. S. Patent 3,078,370. Feb. 19, 1963. Filed Jan. 2, 1958.

An apparatus for gamma-ray logging is designed which allows simultaneous density and natural gamma-ray well logging with a single detector. The apparatus has a gamma source, a detector, a skid urging the apparatus against the well wall, and shielding for housing the source and detector. The detector is of the type emitting electrical pulses related to the energy of the incident rays, and electronic pulse height analyzer circuits are provided for separating the detector signals into channels corresponding to different bands in the gamma energy spectrum. Since the natural gamma rays, the scattered rays, and the borehole rays are of different energies, it is possible to obtain information on the borehole diameter and on the surrounding formations. (D.L.C.)

16409 APPARATUS FOR INDICATING THE METAL OXIDE CONTENT OF A LIQUID METAL. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). U. S. Patent 3,078,412. Feb. 19, 1963. Priority date June 3, 1958, Great Britain.

An apparatus for measuring small changes of electrical resistivity of liquid metals is designed for indicating the content of metal oxide and other impurities in a liquid metal, particularly sodium. The apparatus comprises a pipe for the liquid metal, means for inducing an a-c current through the liquid metal in the pipe, and means for deriving two voltages, one from the current through the liquid metal in the pipe and the other being a reference voltage. Two forms of the apparatus are described. (D.L.C.)

16410 EPITHERMAL NEUTRON DETECTION. Serge A. Scherbatskoy. U. S. Patent 3,080,478. Mar. 5, 1963. Filed Oct. 3, 1957.

A method and apparatus are described for neutron-neutron well logging, using a source of fast neutrons and a detector for epithermal neutrons returning from the formations. The method is based on the fact that the detector response to neutrons of energy 2 ev is unaffected by salt in the well fluid and/or formations and hence is suited for accurate measurement of the porosity of the formations. The detector comprises a phosphor, photomultiplier, and thermal neutron shield; the phosphor consists of a dispersion of neutron-sensitive grains (a mixture of ZnS and B, Li, or Hf) in a transparent matrix. (D.L.C.)

16411 GAMMA RAY CALIPER. William G. Berg and Irwin Ginsburgh (to Standard Oil Co.). U. S. Patent 3,080,479. Mar. 5, 1963. Filed Nov. 27, 1959.

A small apparatus is designed for measuring the wall thickness of an insulated pipe carrying fluids and/or interior coatings at high temperatures. In this apparatus, a source of a collimated beam and a detector are located on opposite sides of the pipe, and the source is moved at constant speed across the pipe cross section. The detector response is recorded on a paper strip, and the pipe wall thickness is obtained by multiplying the rate of source movement by the time interval between the commencement of radiation absorption by the pipe and the maximum ab-

sorption produced by the beam passing through the pipe wall along a tangent. (D.L.C.)

16412 APPARATUS FOR DEEP-WELL LOGGING. Serge A. Scherbatskoy. U. S. Patent 3,080,480. Mar. 5, 1963. Filed Oct. 14, 1958.

A neutron-neutron and neutron-gamma logging apparatus is designed with spectrally selective detectors. The spectral selectivity can be controlled from the earth's surface, and the apparatus is suitable for detecting connate water in the formations. (D.L.C.)

16413 RADIATION DETECTOR. Serge A. Scherbatskoy. U. S. Patent 3,080,482. Mar. 5, 1963. Filed Oct. 16, 1959.

A method and a logging apparatus are described for differentiating between various elements in well formations. The method is based on delayed coincidence of gamma rays after neutron capture. The apparatus includes a shielded neutron source, two detectors, delay networks, coincidence networks, and frequency-measuring networks. (D.L.C.)

16414 METHOD OF CEMENT DETECTION BY NUCLEAR LOGGING. John C. Wilson (to Dresser Industries, Inc.). U. S. Patent 3,081,401. Mar. 12, 1963. Filed May 5, 1959.

A method is given for locating cement between the casing and the wall of the borehole during the logging of the other formations. The method comprises passing a source of neutrons and gamma rays through the borehole, detecting the scattered gamma rays and the gamma rays induced by the neutrons, establishing separate electrical signals indicative of the energies of the scattered and induced gamma rays, and recording the two signals on the same paper strip. The cement is located by comparing the signals. (D.L.C.)

16415 NEUTRON GENERATING APPARATUS. Wayne R. Arnold (to Schlumberger Well Surveying Corp.). U. S. Patent 3,082,326. Mar. 19, 1963. Filed Mar. 8, 1954.

A neutron generator is designed which is particularly suited for well logging service. The generator comprises an ion source, an ion accelerator, and a target. In the ion source, D_2 gas is excited by r-f, and the positive ions are accelerated onto a T_2-containing target to produce neutrons. The generator is controlled by adjusting the potential of the accelerating gap. (D.L.C.)

Radiation Detection

Refer also to abstracts 16056, 16879, 16881, 16892, 16893, 16895, 16896, 16897, 16898, and 16902.

16416 (AD-283918L) PHASE I FINAL DEVELOPMENT REPORT FOR THERMOLUMINESCENT DOSIMETER COMPUTER-INDICATOR SYSTEM. [Period Covered] July 3 to September 3, 1961. (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Aug. 15, 1961. Contract NObsr-85506. 23p.

A study of fabrication techniques and materials for use in personnel-monitoring thermoelectric dosimeter systems was made. The information and data obtained is the basis of Phase II developmental work to be done on incorporation of Mn-activated CaF_2 phosphors into the personnel dosimeter system. (J.R.D.)

16417 (AERE-R-4165) A CALIBRATION TECHNIQUE FOR THE DETERMINATION OF RADON-222 AND ITS APPLICATION TO VARIOUS MEASURING INSTRUMENTS. J. A. B. Gibson (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Jan. 1963. 21p.

A series of Ra solutions ranging from 10^{-12} to 10^{-7} curies was compared and standardized for the calibration of instruments used for measuring Rn. Three instruments for measuring Rn in breath, in laboratory air and in boreholes used in U prospecting, were calibrated using a known quantity of Rn. For the Rn-in-breath apparatus the mean radon activity required to double background was 4.7×10^{-14} c/l (efficiency 42%) and the limit of detection was 10^{-14} c/l representing approximately 10^{-9} curies or 0.01 maximum permissible burdens of Ra in the body. The exhaled Rn fraction determined for 5 subjects with known Ra burdens varied from 0.57 to 0.75. The Rn-in-air apparatus had a Rn sensitivity of 4 counts per second per 10^{-10} c/l and a limit of detection of 5×10^{-12} c/l. The Rn-in-borehole monitor gave 1.7 counts per minute from 10^{-11} c/l and had a limit of detection of 2×10^{-12} c/l. (auth)

16418 (BNL-6865) ČERENKOV AND SCINTILLATION PROPERTIES OF PLEXIGLAS UVT AND UVA. D. Balzarini (Brookhaven National Lab., Upton, N. Y.). Sept. 1960. Contract [AT(30-2)-Gen-16]. 10p.

The scintillation and Cherenkov properties of UVA (ultraviolet absorbing) and UVT (ultraviolet transmitting) Plexiglas specimens were tested by analyzing cosmic-ray-induced pulses traversing the materials. It was found that the UVT sample has less than $\frac{1}{6}$ the scintillation effect of UVA and is preferred for use in counters. (J.R.D.)

16419 (BNL-6871) FAST ANALYSIS SYSTEM FOR BUBBLE CHAMBER DATA. Paul V. C. Hough (Brookhaven National Lab., Upton, N. Y.). Jan. 25, 1963. Contract [AT-30-2-GEN-16]. 28p.

A type of precision measuring instrument, a flying spot digitizer, for the analysis of bubble chamber data is described. When the flying spot encounters a bubble image, it is attenuated typically 25 to 75% depending on the directness of hit and the bubble chamber photographic and operating parameters. The width of the bell-shaped attenuation curve is ~ the sum of the spot and bubble image diameters, or 40 to 50 μ. The high precision of the FSD derives from the fact that it is possible to find the center of area of the attenuation curve to a standard deviation of 3 to 4 μ out of the much larger full-width at the base. Each flying spot coordinate is of a precision ~ equal to that given by a measuring projector, but typically 16 flying spot points are obtained to one measuring-projector point, so that the effective error is only $\frac{1}{4}$ as large. The digital electronics problem associated with a flying spot digitizer is basically the trapping of the grating count at the time a bubble image center is found, the storage of the number temporarily until the computer is free, and then the transmission of the coordinate to the computer. (H.G.G.)

16420 (CEA-2185) LA POMPE À DIODES, SON APPLICATION AU COMPTAGE DE PARTICULES NUCLÉAIRES ET À LA DÉTECTION DES EXCURSIONS RAPIDES DE PUISSANCE D'UNE PILE ATOMIQUE. (The Diode Pump—Its Application to Nuclear Particle Counting and to the Detection of Rapid Neutronic Power Excursions in Atomic Piles). Georges Nicolo (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 86p.

Thesis submitted to Université, Paris.

Work was carried out on three applications of an electronic device whose principle is based on that of the diode

pump: linear response circuit, logarithmic response circuit, and detection of neutronic power excursions in atomic piles using a circuit or a combination of several circuits of the linear response type. Each of the applications was studied theoretically and experimentally. Finally, the detection of rapid power excursions is extensively discussed with reference to the many methods available, with emphasis on the rapidity of the electronic response. (auth)

16421 (CEA-2194) DÉTERMINATION DE LA FORME DES IMPULSIONS LUMINESUSES TRÈS BRÊVES. APPLICATION AUX PHÉNOMÈNES DE SCINTILLATION. (Determination of the Form of Very Short Luminous Pulses. Application to Scintillation Phenomena). Yves Koechlin (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 78p.

Thesis submitted to Université, Paris.

During studies on photomultipliers and scintillators a method of measurement was developed making it possible to determine with precision the form of luminous pulses whose duration may be less than that of an anodic photomultiplier pulse. This method, which can be applied to non-recurrent pulses, makes possible the study of scintillations caused by particles of photons in the case where it is possible to operate on a large number of pulses having the same form. The form of the scintillations of various fluorescent liquids excited by α particles and γ photons was thus determined. The results obtained are in agreement with the energy transfer theory for organic liquids elaborated by H. Kallmann and M. Furst. The results are used to determine exactly the parameters occurring in the theory. (auth)

16422 (ISS-62/4) CORREZIONI DOVUTE A SCATTERING IN UN TELESCOPIO DI CONTATORI DI FORMA QUADRATA. (Corrections for Particle Loss Due to Scattering in a Square Counter Telescope). G. Matthiae (Italy. Istituto Superiore di Sanità, Rome). Feb. 1962. 26p.

A simple method was developed for estimating the probability that a particle that traverses a thin scatterer would strike a counter. The counter is square. The ratio F of the incident beam that is detected by the counter to that detected if no scatterer were present can also be evaluated. This calculation is made in a general form for a beam of any rectangular shape. The results are presented as graphs that may be used also for other geometries. (auth)

16423 (ISS-62/9) THE FREE AIR IONISATION CHAMBER IN THE ISTITUTO SUPERIORE DI SANITA. PART I. M. Chiozzotto (Italy. Istituto Superiore di Sanità, Rome). Mar. 10, 1962. 48p.

The free air chamber, designed and constructed in the Laboratory of Physics of the Istituto Superiore di Sanità, is described. The requirements for the correct behavior of the instrument are discussed and an analysis of the correction factors for approximations involved in the practical construction of the instrument is presented. The first experimental results obtained are also reported. (auth)

16424 (ISS-62/10) THE FREE AIR IONISATION CHAMBER IN THE ISTITUTO SUPERIORE DI SANITA. PART II. M. Chiozzotto (Italy. Istituto Superiore di Sanità, Rome). Mar. 10, 1962. 51p.

A free air ionization chamber designed to operate with x rays produced under differences of potential from about 50 to 400 kv is described. Features of air-chamber shielding and the rail system for positioning the air-chamber are discussed. The laboratory in which the air-chamber apparatus is installed is also described. Discussions are also included concerning the system for measuring electric charge, corrections for exposure calculations, and standardization of the x ray beam. (J.R.D.)

16425 (ISS-62/11) PROGRAMMA PER IL CALCOLO DELLE RADICI DI UN POLINOMIO DI GRADO N MEDIANTE IL CALCOLATORE IBM 610. (Program for Calculating the Roots of an n Degree Polynominal on the 610 IBM Electronic Computer). F. Sgarlata (Italy. Istituto Superiore di Sanità, Rome). Mar. 20, 1962. 33p.

A program is outlined for solving a polynominal a(x) of n = 2m degree on the 610 IBM electronic computer (max. n = 18). Using the Bairstow iterative process the approximate quadratic factor is determined. The degree of polynomial is successively lowered. Thus m quadratic polynomials are found. Each quadratic polynomial deduced from a polynomial of lowered degree is tested in the given polynomial a(x) for reduction of rounding errors. The roots of quadratic polynomials are defined by the usual formula. (auth)

16426 (ISS-62/26) UNA APPARECCHIATURA PER LA RIVELAZIONE AD ALTO POTERE RISOLUTIVO DELLE COINCIDENZE TRA FOTONI DI BASSA ENERGIA. (A High Resolving Power Apparatus for Detecting Coincidences Between Low Energy Photons). M. A. Di Lazzaro and C. Felici (Italy. Istituto Superiore di Sanità, Rome). July 5, 1962. 30p.

An electronic apparatus with a high resolving power designed to detect coincidences between low energy photons is described. The resolving time obtained for coincidences between photons with an energy of 9 kev and 70 kev is $\tau = 25 \pm 0.17$ ns, very close to the intrinsic jitter of the scintillation counter pulses corresponding to photons with an energy of 9 kev. (auth)

16427 (PPAD-461E) SPARK CHAMBERS WITH FERRITE CORE MEMORIES. J. R. Waters (Princeton–Pennsylvania Accelerator, Princeton, N. J. and Princeton Univ., N. J.). July 17, 1962. Contract AT(30-1)-2137. 11p.

It is demonstrated that small, conventional ferrite memory cores can be used with a wire spark chamber for recording spark locations. This removes the necessity for photographing the spark tracks and enables the information to be fed directly into a computer for analysis. (auth)

16428 (TID-18153) TWO PARAMETER MULTICHANNEL PULSE-HEIGHT ANALYZER. Michael G. Strauss (Argonne National Lab., Ill.). Dec. 1962. Contract [W-31-109-eng-38]. 13p. (UAC-7110)

A system is described in which a conventional single parameter multichannel analyzer is used as a two parameter analyzer. A two parameter selector which selects the coincident events to be studied and the memory section to store them, was developed. Each of the coincident pulse-height distributions, from the two detectors, is applied to one set of deflection plates of a 5-in. cathode-ray tube. While the multichannel analyzer accumulates the X spectrum, a "live" intensity modulated X-Y "map," with a resolution of 100 × 128 channels, may be seen on the CRT screen and stored on polaroid film. Four spectral regions can be selected from this spectrum simultaneously by means of digital windows, each to be stored in one quadrant (128 channels) of the memory of the multichannel analyzer. These spectra can then be read out of the memory with the available multichannel analyzer output equipment. Since digital windows are used rather than conventional single channel analyzers, high resolution and good energy accuracy are achieved. (auth)

16429 (TID-18304) AN ITERATIVE SOLUTION OF THE MATRIX REPRESENTATION OF DETECTION SYSTEMS. R. Gold (Argonne National Lab., Ill.). Jan. 8, 1963. Contract [W-31-109-eng-38]. 31p. (RED-EPM-114)

The problem of unfolding the output data of a detection system is reviewed. Physical implications of the matrix representation of a detection system are discussed. An iterative method of solution is presented. Proof of convergence to the exact solution is given for two-dimensional, triangular and positive definite type response matrices. A comparison of the iteration process with that of direct inversion is presented for a scintillation spectrometer employing a collimated sodium iodide crystal, NaI(Tl), which is commonly utilized for gamma-ray detection. (auth)

16430 (TRG-Report-464) THE DEVELOPMENT OF A FISSION PRODUCT DETECTOR USING HIGH-ENERGY BETA DISCRIMINATION. I. C. Hendry (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). Jan. 7, 1963. 11p.

The design and construction of a high-energy beta detector made of NE 102 plastic scintillator is described. Experimental results indicating the characteristic behavior of the detector are outlined. A description of a station for monitoring gaseous activity using the beta detector along with a gamma detector is given including an indication of how half-life measurements as well as energy discrimination can be used to assist in identifying the source of any activity in the carrier gas. (auth)

16431 (AEC-tr-5558) POCKET DOSIMETER WITH A COMPASS FOR DETERMINING RADIOACTIVE RADIATION. Johannes Simon. Translated by Lydia Venters (Argonne National Lab., Ill.) from Uhr, No. 13, 22-(1962). 4p.

The use of a compass as a pocket dosimeter is described. Instead of a glass plate the compass is covered with a clear acryl glass, which manifests an extremely favorable dielectric constant. Thin, round pieces of paper are pasted to the top of the compass needle. When an electric charge is produced on the acryl glass by rubbing, the compass needle swings out of its horizontal position by 15 to 20° and remains in this position until the charge applied either disappears by itself within 5 to 10 min or the charged state is eliminated by radioinduced ionization. The dosimeter is arranged so that it reacts only at a critical, yet permissible, dose for humans. (M.C.G.)

16432 THE ROLE OF THE FILM BADGE IN PERSONNEL MONITORING. B. E. Jones (Radiological Protection Service, Belmont, Surrey, Eng.). Ann. Occupational Hyg., 4: 104-12(Dec. 1961).

Advantages of the film badge over the pocket dosimeter for personnel monitoring are enumerated and the operation of a large-scale commercial monitoring service utilizing a film dosimeter is described in detail. Defects of ionization chamber pocket dosimeters include sensitivity to mechanical shock, liability to electrical leakage, variation of sensitivity with radiation energy, narrow exposure range, and necessity of recalibration. The film badge is better adapted for the purposes of a large scale monitoring service. It is capable of recording doses due to x or γ rays having effective energies from about 10 kev upward, β rays from 150 kev upward, and thermal neutrons, and also of indicating the type of radiation involved. It is also often possible to deduce from the film the manner in which exposure was received. In addition, the film is capable of recording a wide range of doses from less than $\frac{1}{8}$ of the average weekly permissible level to very large overexposures, and it also provides a permanent record of the dose received. Its chief disadvantage is that it does not provide an immediate reading, as processing and evaluation inevitably introduce a delay in obtaining information about the dose received. Description is given of a film badge containing a filter system, which is used for accurate dosimetry. (P.C.H.)

16433 PERSONNEL DOSIMETRY IN THE PRESENCE OF SOFT RADIATION. W. A. Langmead (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Ann. Occupational Hyg., 4: 119-26(Dec. 1961).

The use of the film badge dosimeter, for the measurement of personal doses of ionizing radiation, is discussed from the point of view of the potential accuracy of the method and its limitations, particularly when used under conditions involving soft x radiation. The use of diagnostic filters in the badge for the analysis of the incident radiation spectrum is considered essential for high accuracy and the importance of correct calibration conditions is emphasized. The measurement of β-radiation is considered briefly and the relation between film blackening and absorbed doses in the organs of the body at risk is discussed from the point of view of reduction of errors. The use of a filter of low atomic number enables a reliable estimate to be made of the energy distribution of the radiation incident on the film by the measurement of the ratio of the apparent doses giving rise to the blackening in that part of the film under this filter and the blackening produced in the unfiltered area. In addition, errors in measurement may be controlled by attention to calibration procedure. The backscatter factor should also be considered. It was concluded that in using near monochromatic radiation it is possible to evaluate the doses appropriate to personnel film blackenings with an accuracy of ±20% or better. For mixed radiations, especially if substantial components of soft x rays and β rays are present in the incident beam, the inaccuracies are somewhat greater, and for high accuracy the use of filters in the film badge design becomes a necessity. (P.C.H.)

16434 SOURCE OF ERROR IN NEUTRON PERSONNEL DOSIMETRY WITH NUCLEAR TRACK EMULSION. K. Becker (Kernforschungsanlage, Jülich, Ger.). Atomkernenergie, 8: 74-7(Feb. 1963). (In German)

The accuracy of the neutron rem dose determination by nuclear track emulsion techniques in personnel dosimetry in the case of the most used Kodak NTA, Type A, emulsion between 0.02 and 20 rem and 0.6 and 20 Mev hardly depends on the directional dependence of the film, subjective counting errors besides, if the γ dose does not exceed 5 to 10 r, neither on the fog granularity. The influence of less exact calibration and energy dependence of the neutron sensitivity as well as the orientation of the dosimeter to the neutron source and the human body and the fading effects are more serious. The fading is studied as a function of relative humidity at 20°C and it is found, that in high relative humidity after several days, nuclear tracks are no more countable. Suitable packing of the film can reduce this effect. One should take care of the evaluation of neutron dose measurements. (auth)

16435 RECOIL RADIATION AS DISTURBING EFFECT IN PROPORTIONAL COUNTERS. W. Fett (Freien Universität, Berlin). Atompraxis, 9: 4-9(Jan. 1963). (In German)

Alpha recoil particles which enter the counting chamber of conventional proportional counters cause impulses which are usually greater than those produced by beta radiation. In a lattice-free interior measurement of beta radiation

from thin open dust-layers which also emit alpha radiation, these atomic rays can cause a disturbance effect corresponding to the height of the alpha rate. The extent of this effect depends mainly on the self-absorption of the preparation. It was examined in its relation to the dust-covering of electrostatically collected samples of atmospheric aerosol. The minimum error was estimated. (auth)

16436 A VACUUM CHAMBER FOR MEASURING HIGH DOSAGE RATES OF HARD X- AND γ-RADIATION. F. N. Kharadzha. USSR Patent 149,155. Byul. Izobret., No. 15, (1962).

A vacuum chamber for measuring high dosage rates of hard x and γ radiation, consisting of a high-voltage and a measuring electrode, both of metal, is described. The operation is based on the phenomenon of emission of photoelectrons and recoil electrons by solid bodies under the effect of x rays. To make the chamber portable and widen its range of application, it is made as a three-electrode glass device with a constant high vacuum. A shielding metal electrode is inserted to reduce leakage currents. A grounded metal casing can be placed inside to screen it from the effect of external electrical fields. To reduce absorption of the radiation, the high-voltage electrode has a thin-walled beryllium inlet window. For collimating the radiation, the grounded metal casting has a lead diaphragm. (P.C.H.)

16437 AZIMUTHAL μ-MESON TELESCOPE. L. V. Kozak, E. V. Kolomeets, L. A. Mirkin, B. A. Prilepskii, and V. I. Roshchupkin. Geomagnetizm i Aeronomiya, 2: 1148-50(Nov.-Dec. 1962).

An azimuthal μ-meson telescope was installed at a cosmic-ray station for continuous recording of the directed intensity of the hard component. Each pair of the four identical sections, which constitute the instrument, records particles moving at the same zenith angle but from opposite azimuths, thereby insuring a double recording of the intensity from each direction. Each of three series of counters in a section contains four counters in parallel. A lead screen 10 cm thick between the lower and middle series separates the hard component. Each series of counters has its own quenching circuit. The counter series are connected to a triple coincidence circuit, which is activated by signals with an amplitude >8 v. The pulse from the coincidence circuit is taken first to the amplitude discriminator and then to the computer device, a radiometer. The readings from the duplicating counter registers, set on the panel of the photorecorder of the neutron monitor, are recorded on photographic film every 5 to 15 min. (OTS)

16438 STUDIES OF CONTINUOUS SPECTRA OF FAST NEUTRONS AND γ QUANTA BY MEANS OF COUNTING EFFICIENCY. G. G. Doroshenko and A. V. Larichev. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 141-6(Jan. 1963). (In Russian)

Continuous spectra of weak fluxes were studied using a new spectrometric method that employs a known absolute counting efficiency (ε) as a function of fast neutron or γ energy and detector threshold. The counting efficiency principle is based on the probability that a given quantum would be recorded at a given energy threshold: $\epsilon(E,B) = \epsilon_0(E) \cdot K(E,B)$ (where $\epsilon_0(E)$ is the probability of quantum interaction in the detector sensitive region, K(E,B) is the probability of recording the interaction at the energy threshold B). Theoretically it is possible to obtain a precision of ~1% of ε(E,B). Analyses were made of the Po–Be neutron spectra and the γ spectra from shielded Co^{60}. Counting efficiencies were derived for Hg^{203}, Cs^{137}, Zn^{65}, and Na^{24}. (R.V.J.)

16439 THE USE OF A COINCIDENCE METHOD IN ABSOLUTE ACTIVITY MEASUREMENTS OF BETA-GAMMA SOURCES. Lubomír David (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Prague). Jaderna Energie, 9: 14-19(1963). (In Czech)

The fundamental principles of absolute activity measurement of some beta-gamma sources using a basic modification of the coincidence method are described; general conditions for the use of this method are determined; and an analysis of random and systematic errors are given. Besides the description of auxiliary measurements, some examples of results of absolute Au^{198} activity measurement are reported. An original method of detection efficiency determination of an end-window beta counter to gamma radiation was derived and is appended. (auth)

16440 DELAYED COINCIDENCE COUNTER FOR THE ASSAY OF ACTINON AND THORON. Charles Giffin, Aaron Kaufman, and Wallace Broecker (Columbia Univ., Palisades, New York). J. Geophys. Res., 68: 1749-57(Mar. 15, 1963).

A highly sensitive system for the detection of small quantities of Rn^{219} ($T_{½}$ = 3.92 sec) and Rn^{220} ($T_{½}$ = 54.5 sec) was developed. These isotopes are continually swept from a 5-ml acid solution containing their parents into a highly efficient 2-liter scintillation counter. Through the use of a delayed coincidence technique involving the short-lived decay products of the emanation isotopes (Po^{215}, $T_{½}$ = 1.8 msec and Po^{216}, $T_{½}$ = 0.16 sec), the counter background is substantially reduced (0.03 cpm for actinon and 0.15 for thoron counting). The over-all detection efficiencies are 45 and 46 per cent, respectively. With this system as little as 4×10^{-12} gram Pa^{231} per gram (equivalent to 2×10^{-7} gram U^{238} per gram) and 2×10^{-6} gram Th^{232} per gram can be detected in 30-gram samples of carbonate minerals. (auth)

16441 THE NITROUS OXIDE RADIATION DOSIMETER. G. R. A. Johnson (Kings Coll., Newcastle upon Tyne, Eng.). J. Inorg. Nucl. Chem., 24: 461-8(Nov. 1962).

The initial yield of nitrogen from nitrous oxide (1 atm, 20°C) irradiated with Co^{60} γ rays was $G_{N_2} = 12.8 \pm 0.4$ molecules per 100 ev. The energy absorption was determined by ionization current measurements. Determination of the energy absorbed by the Fricke dosimeter gave $G_{N_2} = 12.0 \pm 0.4$. The initial G_{N_2} was independent of the pressure of N_2O between 200 and 760 mm Hg and of dose rate between 0.73 and 3.0×10^{14} ev ml^{-1} min^{-1}. G_{N_2} was not independent of total dose but decreased at doses greater than about 2.4×10^{17} ev ml^{-1}, having a value of 9.3 at 2.5×10^{18} ev ml^{-1}. The yields of nitrite, formed when the irradiated gas was extracted with sodium hydroxide solution, and of oxygen were determined. (auth)

16442 CONTRIBUTION TO THE STUDY OF AN IONIZATION CLOUD CHAMBER. APPLICATION TO THE MEASUREMENT OF IONIZATION POTENTIALS OF ALCOHOL VAPORS BY THE CORONA EFFECT. B. Volochine (Faculté des Sciences, Orsay, France). J. Phys. Radium, 23: 901-5(Nov. 1962). (In French)

A theoretical study of an ionization cloud chamber operating with alcohol vapor diffusing in argon at normal pressure and with a strong temperature gradient is presented. The first part of this work is a theoretical study of the parameters determining the working conditions of such devices (i.e., thickness and quality of the sensitive layer). The calculated thickness of the sensitive layer is consistent with the experimental observations. The second part of this work is a brief analysis of principal defects affecting the working conditions, hence the dead time, of this type of ionization chamber. (auth)

16443 SELECTION AND APPLICATION OF GEIGER-MUELLER COUNTERS. U. Kaczmarek (Johannes-Kepler-Polytechnikum, Regensburg, Ger.). Kerntechnik, 5: 1-6 (Jan. 1963). (In German)

The numerous characteristics and data of Geiger-Mueller counters (end window, cylinder, flow, dipping, and liquid counters) are compiled. The data for especially measuring practice are explained. Formulas, diagrams, and figures as well as instructions for measuring and practical advice for handling are described. (auth)

16444 AUTOMATIC RECORDER FOR GM-COUNTER CHARACTERISTICS. G. Moll (Hahn-Meitner-Institut für Kernforschung, Berlin). Kerntechnik, 5: 7-9(Jan. 1963). (In German)

The device described is used in connection with a recorder for automatic recording of the characteristics of GM-counters. High voltage is variable between 100 and 2500 v. As recorders can be connected: 1. x-y-recorder, the available x-voltage is proportional to the counter voltage; 2. potentiometer recorder. An automatic record takes 15 min. (auth)

16445 A SHIELDED SAMPLE CHANGER FOR COINCIDENCE MEASUREMENTS. W. Schneider (Kernforschungsanlage des Landes Nordrhein-Westfalen, Jülich, Ger.). Kerntechnik, 5: 13-14(Jan. 1963). (In German)

For absolute measurements of radioactive source strengths using the beta-gamma coincidence method or for similar measurement techniques with two detectors, a shielded sample changer was built which permits one to localize both the detectors and the samples in reproducible positions, to lower the background, and to insert various forms of detectors and samples. (auth)

16446 COMPARATIVE MEASUREMENTS OF ALPHA ACTIVITIES WITH FAST IONIZATION CHAMBER AND METHAN FLOW COUNTER. R. Tzschaschel (Kernforschungsanlage des Landes Nordrhein-Westfalen, Jülich, Ger.). Kerntechnik, 5: 15-16(Jan. 1963). (In German)

With a pulse ionization chamber for measuring α activities, the influence of geometry from different sample supports was examined, and in particular comparative measurements with methane flow counters were carried out. The result was that the ionization chamber has essential advantages with respect to the methane counter. The use of air under normal atmospheric pressure as filling gas enables quick change of samples. The counting efficiency will be higher because of the favorable geometry, and the influence of an inhomogeneous distribution of activities on the sample supports is substantially smaller than for a methane counter. For the measurement of α activities in presence of high β background the ionization chamber surpasses the methane counter also. (auth)

16447 CONSTRUCTION OF THE BENT CRYSTAL GAMMA RAY SPECTROMETER FOR THE DR-3 REACTOR AT RISÖ. U. Gruber, B. P. Maier, and O. W. B. Schult (Technische Hochschule, Munich). Kerntechnik, 5: 17-19(Jan. 1963). (In German)

The construction of a bent crystal spectrometer for the measurement of neutron capture gamma rays at a reactor is described. Advantageous construction units are a wire-bearing and an air-bearing which are considered in detail. (auth)

16448 EQUIPMENT OF THE BENT CRYSTAL GAMMA RAY SPECTROMETER FOR USE AT THE DR-3 REACTOR AT RISÖ. B. P. Maier, U. Gruber, and O. W. B. Schult (Technische Hochschule, Munich). Kerntechnik, 5: 19-20(Jan. 1963). (In German)

The essential elements of a bent crystal spectrometer for the measurement of neutron capture gamma radiation are described: crystal, crystal holder, lead plates collimator, detector, a block diagram of the electronic units, and an arrangement for automatic recording and angular measurement. (auth)

16449 STATISTICAL ERROR AND MEASURING TIME IN COUNTING NUCLEAR RADIATION PULSES. L. Weise. Kerntechnik, 5: 21-4(Jan. 1963). (In German)

A treatment is presented of irregularities in the statistical errors of nuclear decay. Equations for the statistical errors are given in terms of the pulse count and measuring time. The principle of the smallest total measuring time is discussed. The choice of the relation for the measuring time or pulse count is considered. The shortening of the measuring time by reduction of the null effect is discussed. (D.L.C.)

16450 CHROMATOGRAPHY READER. E. Petrozzi. Minerva Nucl., 6: 347-50(Nov. 1962). (In Italian)

Various types of automatic equipment for the localization and measurement of radioactive spots on paper strips or sheets are described and compared. The relations among time, tracer, error, and spot definition were examined and found to be essentially similar for both continuous and step-by-step equipment, as expected. Some practical data and some typical values for sensitivity, measuring time, and results are reported. A number of practical suggestions are made. (auth)

16451 BULK PHOTOCONDUCTIVITY DETECTOR SUITABLE FOR GAMMA RADIATION. Colin G. Clayton and J. Barrie Whittaker (Wantage Research Lab., Berks, Eng.). Nucleonics, 21: No. 4, 60-4(Apr. 1963).

The bulk photoconductivity detector is better suited for detecting single events than junction-type semiconductor detectors. Two suitable materials are silicon and gallium arsenide, and the properties of these and other materials are tabulated. A model for the bulk detector is considered, and the factors affecting the performance, sensitivity, dose-rate dependence, and speed of response are discussed. Various applications are described. (D.L.C.)

16452 DOSIMETRY OF SPACE RADIATIONS. Norman A. Baily and K. M. Hoalst (Hughes Research Lab., Malibu, Calif.). Nucleonics, 21: No. 4, 68; 70; 72-3(Apr. 1963).

An instrumentation system was developed for measuring absorbed dose at five places in a tissue-equivalent manikin during space flight. The system contains ionization chambers made in three different sizes from tissue-equivalent materials and functions according to the Bragg-Gray principle in the range 0.01 to 100 rad/hr. The electronics and performance of the ionization chamber are discussed. The environmental tests carried out are described. (D.L.C.)

16453 MEASURING PARTICLE VELOCITIES WITH ČERENKOV RINGS. John R. Waters (California Inst. of Tech., Pasadena). Nucleonics, 21: No. 4, 74; 76(Apr. 1963).

A Cherenkov detector system with an image intensifier was developed for measuring particle velocities. The system was tested in a beam of 820-Mev/c π^- mesons; the observed number of spots in the ring was much lower than expected. The faults of the system and possible improvements are discussed. (D.L.C.)

16454 MECHANISM FOR AUTOMATIC STEERING OF NEUTRON SPECTROMETER. Stanisław Kolber and Jan Ściesiński (Inst. of Nuclear Physics, Kraków). Nukleonika, 7: 193-6(1962). (In Polish)

The mechanism was designed for the automatic steering of a two-axis neutron crystal spectrometer, and at the same time, for the automatic registration of the results of the measurement such as time, number of counts in the measuring time, and the angular position of the spectrometer. The type of spectrometer measurements includes the total cross section for thermal neutrons, the inelastic phonon and magnon scattering of neutrons for monochromatic as well as "white"-spectrum of neutrons, and the angular and energy distributions of neutrons scattered from liquid samples. The automatic steering mechanism makes possible the automatic steering of either the spectrometer arms or of the magnoscope with either fixed or varying angle of the first crystalline scatter, with the test sample in or out, and with measurements utilizing magnetic fields. The mechanism can also steer two turntables, one of which can be steered while the angle between the arms of the crystal spectrometer is held constant. The flow diagram (or block diagram) of the mechanism's logic is given, as is also a list of the mechanism's characteristics. (TTT)

16455 CONSTRUCTION AND USE OF HIGH PRESSURE BF_3 NEUTRON PROPORTIONAL COUNTERS. Witold Kůzma. Nukleonika, 7: 585-90(1962). (In Polish)

A series of high pressure BF_3 neutron counters were built. The filling procedure was simplified by the application of flushing the counters with the filling gas. The characteristics of the counters are presented, showing that they are good counters in spite of the very simple filling procedure. The characteristics of the counters did not deteriorate even though some of the counters had already counted about 10^7 neutrons. The construction consisted of a brass cylindrical body of 6-cm. diameter, 41.4-cm. effective length, with a 0.04 mm. tungsten center wire. The brass body was found as satisfactory as other metals in cosmic-ray counters used elsewhere. (TTT)

16456 LOW-FREQUENCY FLUCTUATIONS IN THE COUNTING RATE OF PHOTOMULTIPLIERS. C. Smit, C. Th. J. Alkemade, and W. F. Muntjewerff (Rijksuniversiteit, Utrecht). Physica, 29: 41-9(Jan. 1963). (In English)

The fluctuations in the counting rate of dark current pulses and photocurrent pulses from RCA 1P28 photomultiplier tubes were measured as functions of the average counting rate (up to 10^4 pulses per sec) and the frequency respectively. The dark current shows flicker effect noise, the frequency spectrum of which was obtained in the range of $5 \cdot 10^{-4} - 0.1$ c/s from the auto-correlation function measured. As the total duration of the measurements is limited, the auto-correlation function found shows essentially a negative region which could be theoretically allowed for. There is an (indirect) indication that the flicker noise spectrum might level off at a frequency of about 10^{-4} c/s. The photocurrent pulses appear to obey Poisson statistics (shot noise). The fact that flicker noise occurs in the dark current only and not in the photocurrent, suggests a possible explanation. (auth)

16457 ^{14}C AND ^{3}H MEASUREMENT BY THE USE OF A LIQUID SCINTILLATION SPECTROMETER. II. SIMULTANEOUS COUNTING METHODS OF ^{14}C AND ^{3}H IN THE SAME SAMPLE. Yoshiko Kasida and Tetsuo Iwakura (National Inst. of Radiological Sciences, Tokyo). Radioisotopes (Tokyo), 11: 247-56(Aug. 1962). (In Japanese)

Two methods are analyzed. In one, the pulses from $C^{14}(T)$ are eliminated from the scaler by setting the photomultiplier dynode-anode voltages so as to count efficiently only the $T(C^{14})$ pulses, and then adjusting the photomultiplier voltage to count efficiently only the $C^{14}(T)$ pulses. In the second method, the C^{14} and T pulses are sorted by means of a pulse-height analyzer. The second method is shown to be the more accurate and efficient of the two. (T.F.H.)

16458 ^{14}C AND ^{3}H MEASUREMENT BY THE USE OF A LIQUID SCINTILLATION SPECTROMETER. III. COUNTING VIALS. Yoshiko Kasida and Tetsuo Iwakura (National Inst. of Radiological Sciences, Tokyo). Radioisotopes (Tokyo), 11: 257-64(Aug. 1962). (In Japanese)

Vials made of low-K-content glass, quartz, Vycor, polyethylene, Pyrex, and two other types of glass are evaluated for their C^{14} and T counting efficiency and their background radioactivity. (T.F.H.)

16459 EFFECTS OF THE RELATIVE HUMIDITY ON LATENT IMAGE FADING AND SENSITIVITY OF THE FILM EMULSION. I. Miyanaga, T. Nishi, and Y. Izumi (Japan Atomic Energy Research Inst., Tokyo). Radioisotopes (Tokyo), 11: 318-24(Aug. 1962). (In Japanese)

Latent-image fading and sensitivity of Fuji Badge Film (Type A) is determined at relative humidities of 30 to 90%, near 25°C. Doses up to 1 r are considered. (T.F.H.)

16460 MEASUREMENTS ON BUBBLE CHAMBER PHOTOGRAPHS. Rev. Gen. Electronique, 17: No. 194, 47-8(Jan. 1963). (In French)

Scanning and measuring bubble chamber photographs require precision and rapidity of use. The ENETRA-110 designed for this purpose gives extreme precision and ease of use. The principles of this machine are illustrated by means of sketches. (J.S.R.)

16461 SYNCHROSCOPE FOR STUDYING FAST PROCESSES. J. Resl and I. Petr. Slaboproudy Obzor, 23: 621-5(Nov. 1962).

A synchroscope designed for observing transients with a duration of up to two nanosec or periodic processes with a frequency of up to 500 mC is described. The device serves predominantly for studying rapid coincidence circuits, certain nuclear and statistical processes, and other pulse techniques. The main component of the device is a special micropicture tube with a traveling-wave vertical-deflection system. Deficiencies of conventional picture tubes, such as image distortions caused by effects of electron transit time and spurious capacitances and inductances of supply leads, are substantially reduced by the appropriate selection of built-in feeders loaded with characteristic impedance. The time base is produced by a nanosecond blocking oscillator and three stages of differentiating circuits fitted with tubes and inductances; it reaches a maximum speed of 2.5×10^9 cm/sec. (OTS)

16462 ON THE ELECTRIC POTENTIAL AND FIELD PATTERN IN THE STANDARD IONIZATION CHAMBERS FOR X-RAY DOSIMETRY. Klaus Willuhn and Manfred Peschel (Physikalisch-Technische Zentralinstitut des Deutschen Amtes für Messwesen, Berlin). Strahlentherapie, 120: 144-56(Jan. 1963). (In German)

Omitting fringe disturbances a comprehensive survey of the distribution of the potential and field of standard ionization chambers is given. Special attention is devoted to the cylinder chamber with an eccentric inner electrode. (auth)

16463 EXPERIMENTAL DETERMINATION OF STATISTICAL RELIABILITY OF A RADIOACTIVE RELAY WITH HYSTERESIS. Kh. E. Gunne. Tr. Inst. Fiz., Akad. Nauk Latv. SSR, 12: 101-8(1961).

A method is suggested for the experimental determination of statistical reliability of a radioactive relay with

hysteresis, working at a counting speed corresponding to the maximum probability of a false switching. The method permits the tentative determination of statistical reliability at other counting speeds as well. The statistical reliability of a radioactive relay with hysteresis is defined by the quantity $1/(1 + N)$ where N is the average number of false switchings during 1 hr at a counting speed corresponding to the maximum probability of a false switching. A radioactive positive-circuit relay is described in which the armature of the output electromagnet is attracted upon the appearance of radiation. The upper-position switchings (lifting) are counted at several radiation-response levels of the controller, close to the response threshold, whereas the lower switchings (lowering) are counted at several levels, close to the release threshold. Discharges are counted by means of an electromechanical counter operated from output contacts of the radioactive relay. When upper-position discharges are counted, the radioactive relay is set in a lowered position. The auxiliary electromagnetic relay, connected in series with the electromechanical counter interrupts the transducer feeding-circuit after each counting pulse for a short while in order to reset the radioactive relay to its lowered position. When lower discharges are counted the radioactive relay is set in the operating position, and the auxiliary relay, after each counting pulse, feeds to the input circuit of the radioactive relay a voltage which activates it. A typical diagram for determining the statical reliability of a radioactive relay with a transducer is shown. (P.C.H.)

16464 PRINCIPLE OF DESIGN OF A MANY-DIMENSIONAL PULSE ANALYZER. R. G. Ofengenden (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 7: 1172-9(Nov. 1962). (In Ukrainian)

A description is given of the block diagram of an analyzer that can be used for the simultaneous measurement of a family of amplitude-amplitude or amplitude-time spectra of nuclear particles. The basic memory device in the analyzer is a magnetic drum, and the intermediate memory devices are recorders with semiconductor triodes. A change in information on the drum is effected by using paired heads and temporary storing of the information of the selected channel on the delay line or on an auxiliary track. The principle of constructing an analyzer for the simultaneous measurement of time spectra from n detectors, is considered, using an intermediate memory device of ferrite cores with rectangular hysteresis loops. Schemes of separate standard analyzer elements are presented. Each of the elements is performed on to a plate with print assembly. (auth)

16465 SMALL-SIZE PULSE-HEIGHT ANALYZER AIMA-3. F. N. Berezin, R. G. Ofengenden, O. M. Rozental, and M. A. Shaleiko (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 7: 1180-90(Nov. 1962). (In Ukrainian)

A description is given of a pulse-height analyzer AIMA-3 with a magnetic drum memory. The analyzer has 50, 80, or 120 channels. Each channel has a capacity of $\sim 2^{16}$ pulses on operating with 50 channels, and $\sim 2^{10}$ pulses on using 80 or 120 channels. The average dead time of the machine is 1.3 msec in the case of 50 or 80 channels, and 1.8 msec with 120 channels. The device permits subtracting the background with a factor of 1, 2, or 4. Only 84 vacuum tubes are used. The analyzer consists of two units, each of $300 \times 450 \times 500$ mm. The operation of some of the circuits and elements is described. The complete principal diagram is given. (auth)

16466 A MOLECULAR BEAM DETECTOR WITH ELECTRON-BOMBARDMENT IONIZATION AND QUADRUPOLE MASS FILTER. H. G. Bennewitz and R. Wedemeyer (Universität, Bonn). Z. Physik, 172: 1-18(1963). (In German)

A molecular beam detector is described which ionizes by electron bombardment. The ions are then separated in a quadrupole mass filter and detected by a multiplier. The special advantages of the mass filter allow a high overall transmission so that every 1000th molecule of the beam is measured as an ion. The ion current due to the residual gas is reduced by a factor of 10^{-6} for all masses >45. These results were achieved without separately pumping or baking out the ionization chamber. Since magnets are not used the detector is comparatively light and small in size. The smallest detectable beam was found to have a current density of 1.8×10^{-6} molecules/sec mm^2 corresponding to 4×10^3 molecules/cm^3, at a vacuum pressure of 8×10^{-7} torr in the apparatus, and using a time constant of 1.25 sec. (auth)

16467 UNIVERSAL DIFFRACTOMETER (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). 83 units. (CAPE-927)

The diffractometer is a general purpose machine used for neutron diffraction experiments primarily at the High Flux Beam Reactor. Single crystals and samples may be studied. The diffractometer is designed to accommodate such accessories as magnets, cryostats, or furnaces. The method of operation is by step scanning. (F.L.S.)

16468 FAST NEUTRON SURVEY METER (Engineering Materials). (Oak Ridge National Lab., Tenn.). 5 drawings. (CAPE-744)

This transistorized, portable survey meter detects fast neutrons in a moderately high gamma field and is designed for use in radiological surveys in the areas of reactors, accelerators, and large neutron sources. Readout for the meter is in the form of count-rate, calibrated in mr/hr. The instrument and batteries weigh 6 lb 12 oz. Full scale counting loss is 1.75%. There is no zero drift, and the calibration drift is less than 10% from the combined effects of temperature and battery-voltage changes. (F.L.S.)

16469 NEUTRON DIFFRACTOMETER, M I (Engineering Materials). (Argonne National Lab., Ill.). 97 units. (CAPE-891)

This diffractometer consists of a shutter, collimator, collimator door, collimator housing, counter shield, plastic dust boot, and a "Pickins" diffractometer. In Argonne National Laboratory it is used in tandem with the neutron diffraction spectrometer M II. (F.L.S.)

16470 NANOCARD LOGICAL MODULES (BNL) (Engineering Materials). (Brookhaven National Lab., Upton, N. Y.). 24 drawings. (CAPE-943)

The nanocard modules form a 100-Mc counting system used in experiments involving accelerators. Current switching logic, accomplished with transistors and germanium tunnel diodes, is used for high speed logic. All circuits have a rise time and time jitter of 2 nsec or less. The chief logical elements are pulse-height limiters, discriminators, multichannel coincidence circuit four-fold fanout, and a scale of eight. The fanout enables a limiter or discriminator output to drive any combination of 4 elements. Each element is a separate plug-in module. Elements are interconnected with 50-ohm cable on a 5-ma level with at least one terminal. All module inputs and outputs are compatible so that a discriminator can drive or be driven from a coincidence circuit. Modules will operate up to a continuous counting rate of 108 pulses per sec. Wide variations in random counting rates may be tolerated. The discriminators

and the scaler have provisions for remote turnoff from auxiliary timing circuits. Exit from the high speed counting circuits to conventional scalers and logic circuits is by a 10-Mc regenerative pulse-amplifier that delivers +9 v pulses into 100 ohms. (F.L.S.)

16471 SOLAR RADIATION MONITORING. John C. Lindsay (National Aeronautics and Space Administration, Greenbelt, Md.). Preprint Paper No. 63-2. New York, Institute of the Aerospace Sciences, 1963. 14p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Brief descriptions are given of the first Orbital Solar Observatory (OSO), its biaxial attitude control system, instruments, and the experiments performed. Although most of the data have not been processed, a few conclusions are drawn. (C.E.S.)

16472 IMPROVEMENTS IN OR RELATING TO ELECTRICAL CIRCUITS FOR SCINTILLATION COUNTING. Alan Clark Cross (to Plessey Co., Ltd.). British Patent 917,046. Jan. 30, 1963. Filed Dec. 19, 1960.

A device is designed for producing fast electrical impulses coincident with the arrival of a particle or ray at a detector. The device comprises a photomultiplier tube whose cathode is connected to receive the output of the detector, and a tunnel diode connected to act at least as a part of the anode load. Means is provided for varying the bias current of the tunnel diode in order to vary its discrimination level. (D.L.C.)

16473 IMPROVEMENTS IN OR RELATING TO SCINTILLATION DOSE AND DOSE-RATE INDICATING APPARATUS. Sydney Norman Pocock (to Mullard Ltd.). British Patent 918,883. Feb. 20, 1963. Filed Mar. 1, 1961.

A scintillation dose-rate indicating apparatus is provided. The apparatus is composed of a scintillating phosphor, photomultiplier, pulse amplifier, threshold discriminator, and pedestal generator. The output is representative of the original scintillation pulses. This output may in turn be integrated to obtain a radiation dose rather than a radiation dose-rate. (C.E.S.)

16474 A NEUTRON FLUX DOSIMETER. (to Compagnie de Saint-Gobain). British Patent 919,192. Feb. 20, 1963. Priority date Sept. 5, 1958, France.

A neutron flux dosimeter is provided that has two juxtaposed zones of heterogeneous glass. One of the zones reacts to neutron irradiation in a manner different from the others. When irradiated the body deforms in proportion to the neutron dosage received. The zones of glass may be threads or sheets. (C.E.S.)

16475 IMPROVEMENTS IN OR RELATING TO RADIATION INDICATORS. Raymond Lester Vale and John Joseph Farrell (to United Kingdom Atomic Energy Authority). British Patent 920,689. Mar. 13, 1963. Filed Nov. 2, 1960.

A radiation indicator is described which comprises an acid-sensitive dye in contact with halogen-containing polymer. When the polymer is irradiated, hydrohalic acid is released which changes the color of the dye. The indicator is in the form of a film deposited from an aqueous emulsion of a polymer and a dye. The radioinduced color changes in such films are more stable than these in films deposited from true solutions of the polymer. The polymer may be polymers and copolymers of vinyl and vinylidene chlorides. The dye may be dimethyl yellow, Waxoline Yellow, metamethyl red, Congo Red, Thymol blue, or xylene cyanol FF. (D.L.C.)

16476 IMPROVEMENTS IN AND RELATING TO MONITORS FOR ALPHA PARTICLES. David John Lockey and Robert Thompson Brunskill (to Nuclear Power Plant Co., Ltd.). British Patent 921,491. Mar. 20, 1963. Filed Dec. 7, 1959.

A monitor is designed with increased sensitivity for detecting and measuring airborne alpha activity (radon). The monitor comprises a series of spaced phosphor plates lying in planes radiating from a common line on the surface of a photomultiplier. The edges of each plate except the edge facing the photomultiplier are silvered to increase internal reflection, and the plates and photomultiplier are located in a light-tight casing through which air is passed. (D.L.C.)

16477 METHOD AND APPARATUS FOR THE MEASUREMENT OF A FLUX OF NEUTRONS. Pierre G. Le Clerc (to Compagnie de Saint-Gobain). Canadian Patent 655,091. Jan. 1, 1963. Priority date Sept. 5, 1958, France.

A neutron dosimeter of very small dimensions is provided. An analyzer of neutrons that is deformed proportional to the quantity of neutrons received is provided by uniting in a single glass object two glasses that undergo different volume changes under irradiation. In use, the analyzer is standardized and measures quantities or flow of neutrons. (C.E.S.)

16478 RADIATION WARNING DEVICE. Alan K. Knowles (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 655,587. Jan. 8, 1963. Filed June 16, 1960.

A small radiation-warning device is described which emits an audible signal increasing in pitch with increasing radiation intensity. The control electrode of a triode is directly connected to one of the electrodes of an ionization chamber. This arrangement constitutes the active elements in a blocking oscillator using the gap of the ionization chamber as the grid resistor. The capacity is that of the interelectrode distances of the ionization chamber and the tube. The whole is enclosed in one envelope so as to be unaffected by humidity. It requires a low operating voltage and current and can be plugged into radio receivers. (T.R.H.)

16479 DIRECT-READING CHEMICAL RADIATION DOSIMETER COMPOSED OF SOLIDS. Karlheinz Pfoertner. German Patent DAS 1,142,038. Jan. 3, 1963. Filed Feb. 29, 1960.

A chemical radiation dosimeter for measuring various kinds of ionizing radiations (x rays, γ rays, protons, electrons, alpha particles) is described. It is composed of a transparent solid polymer, such as vinyl plastics or polyester resins, which is soluble in an organic solvent. Either a halogenated hydrocarbon such as bromoform, tetrachlorethane, iodoform, etc., or an inorganic compound such as IBr, ICl, PbI, $HgCl_2$, HgBr or HgI is added to the polymer. Finally, the leuco compound of a dye is dissolved in the solid solution to serve both as sensitizer and indicator, changing to the colored form when the halogen compound is irradiated, in a manner which can be reproduced and easily estimated. The extinction at the absorption maximum is either a linear or an exponential function of the dosage depending on the relative concentrations of the halogen compounds and the dye. For extending the measuring range, it is suggested to add a base like ammonia, diethylenetetriamine, or triethylenetetramine. The geometrical form of the dosimeter can be most freely chosen as it can be easily machined. (Gmelin Institute)

16480 GAS FILLED DOSIMETER. Ole G. Landsverk and Delbert L. Merriner (to Landsverk Electrometer Co.). U. S. Patent 3,075,081. Jan. 22, 1963. Filed Aug. 12, 1958.

An improved quartz-fiber dosimeter and pocket chamber dosimeter were patented. They are filled with an inert gas mixture having an effective atomic number of about 7.2 or a gas mixture of 7 parts of N to 1 part of Ar. The sensitivity of the improved dosimeters remains relatively constant throughout their effective life. The design of the dosimeters and methods for filling the dosimeters with gas are described. (M.P.G.)

16481 RADIATION DETECTOR. John C. Connor (to Westinghouse Electric Corp.). U. S. Patent 3,075,116. Jan. 22, 1963. Filed Sept. 8, 1958.

A neutron detector is described, which has a high sensitivity to thermal neutrons and a minimum response to γ radiation. The BF_3-gas-filled detector can operate reliably and continuously at elevated temperatures, in dense neutron flux, and when subjected to severe shock and vibration. The design and construction of the detector are described in detail. (M.P.G.)

16482 RADIO FLUID DETECTOR. Kenneth A. Kiesel, Edward L. Webb, Donald V. Smith, and Zane L. Collins (to Westinghouse Electric Corp.). U. S. Patent 3,076,093. Jan. 29, 1963. Filed Oct. 28, 1958.

A radiation detector for measuring the β activity of gases or other fluids in the presence of a high level of γ radiation was developed. The detector consists of a hollow shell with a phosphor coating applied to the inner surface, a means for admitting a fluid and conducting it to a substantial area of the coating, and a lens and photomultiplier tube for translating the light emitted by the coating into an electrical signal. (M.P.G.)

16483 RADIOACTIVITY DETECTOR. Harry R. Lubcke. U. S. Patent 3,076,094. Jan. 29, 1963. Filed Feb. 19, 1959.

A radioactivity detector was developed, in which a semiconductor oscillator is inhibited from oscillating until the semiconductor is exposed to γ radiation. The detector consists of a transistor oscillator with adjustable resistors in the transistor electrode circuits, an acceptor metal such as Cu in contact with the semiconductor, and a source of weak light irradiation for the semiconductor. The circuit is adjusted so that oscillation is inhibited. Exposure to radioactivity decreases the inhibition, causing the circuit to oscillate. This device is applicable to well logging. (M.P.G.)

16484 NEUTRON DETECTOR. George C. Baldwin (to General Electric Co.). U. S. Patent 3,076,895. Feb. 5, 1963. Filed Apr. 28, 1960.

A neutron detecting device for producing a visible indication of an impinging neutron flux was designed. This device is particularly useful in neutron radiography. The detector consists of a pair of electrodes, one of which is covered with a neutron-sensitive ionizing-particle-emitting material such as boron. The other electrode is covered with an optically transparent conducting film. The voltage impressed across the electrodes is just below the magnitude necessary to produce spark-over. A discrete spark discharge takes place at the point of neutron impingement on the boron-coated electrode. The light patterns produced by the spark discharges are photographed through the transparent electrode to provide a visual representation of the neutron radiograph. (M.P.G.)

16485 X-RAY BEAM INTENSITY RESPONSIVE SEQUENTIAL SPECTROMETER. Arthur Long (to Hilger and Watts Ltd.). U. S. Patent 3,079,499. Feb. 26, 1963. Priority date June 19, 1959, Great Britain.

An x-ray spectrometer is designed which is simple in operation in that the sequential adjustments and measurements are performed automatically according to a preset program. The spectrometer has a detector adapted for movement to different parts of the spectrum and preset electrical switching means for controlling the detector movement. (D.L.C.)

16486 SYSTEM FOR RECORDING PARALLEL X-RAYS. La Verne S. Birks, Jr. (to U. S. Navy). U. S. Patent 3,079,501. Feb. 26, 1963. Filed Sept. 29, 1960.

A device is designed for recording the spectra of a solar source of parallel x rays. The device comprises a parabolic mirror reflector positioned to receive the x rays at an angle of incidence of 5° or less, a curved diffraction grating positioned relative to the reflector to receive divergent x rays therefrom, and recording means positioned relative to the grating to record the spectra. (D.L.C.)

16487 RADIATION ANALYSIS. Henry R. Chope and Albert F. G. Hanken (to Industrial Nucleonics Corp.). U. S. Patent 3,082,323. Mar. 19, 1963. Filed June 25, 1958.

A method and an instrument are described for quantitatively analyzing a composite material for its constituents and/or physical qualities. This method comprises directing simultaneously a plurality of different radiations through a material, detecting the radiations to give a plurality of electrical signals, and solving the resulting linear simultaneous equations on an analog computer. Several examples of the use of the method are given. (D.L.C.)

16488 RADIATION MEASURING APPARATUS. Edward M. Speyer (to American Machine and Foundry Co.). U. S. Patent 3,082,325. Mar. 19, 1963. Filed Dec. 16, 1960.

A thermal radiation detector of the modulated type is designed which is characterized by both high sensitivity and high operating frequency. This increase in both sensitivity and frequency is accomplished by cooling the detector during the time periods when the radiation beam is interrupted. (D.L.C.)

ISOTOPE SEPARATION

16489 (DP-261) ISOTOPIC PURIFICATION OF TRITIUM BY ELECTROLYSIS. B. S. Johnson, Jr., J. T. Grace, D. G. Karraker, L. H. Meyer, and C. K. Nicholson (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). May 1958. Contract AT(07-2)-1. 81p.

An electrolytic refining process was developed to produce T of high isotopic purity with negligible loss. The operation is semicontinuous, with multiple states in cascade. All T_2O is handled within the confines of a hermetically sealed enclosure. The mechanical operability of the process was demonstrated in a five-stage prototype line designed to process 15 gram-mols of feed per day. An average separation factor per stage of 5.3 was obtained with a feed of tracer-level T. The equipment is described in detail. (auth)

16490 (DP-732) LOW TEMPERATURE STILL FOR SEPARATION OF HYDROGEN ISOTOPES. Ben S. Johnson and Francis G. Rust (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Sept. 1962. Contract AT(07-2)-1. 36p.

Separation of hydrogen isotopes by continuous distillation was demonstrated with hydrogen and deuterium in a pilot-scale still with a packed column 2-in. in diameter. Theoretical plate heights of 1 to 4 in. were observed. Excellent insulation was essential to avoid excessive consumption of liquid hydrogen coolant. A method for data evaluation in ternary distillation is presented. (auth)

16491 THE EXISTENCE OF A "NEGATIVE" ENRICHMENT EFFECT DURING THE THERMO-DIFFUSION OF A GAS IN A POROUS MEDIUM. B. N. Goshchitskii and I. S. Izrailevich. Dokl. Akad. Nauk SSSR, 147: 817-18(Dec. 1, 1962). (In Russian)

A "negative" enrichment effect consisting of an increase in the concentration of the light component at the cold end of a capillary was observed in studying the thermo-diffusion of gases in capillaries at low value of d/λ, where d is the diameter of the capillary, and λ is the mean free path of the molecule. Gaseous mixtures of H_2 and Ar, H_2 and Kr, and He with Kr were allowed to diffuse through a porous membrane from a volume V_1 at temperature T_1 to a volume V_2 at a temperature T_2. A positive separation effect was noted at low "hydraulic" resistance (the light component was enriched in the "hot" vessel). The composition of the mixtures was obtained from thermal conductivity measurements. It was shown that a "positive" enrichment effect is always obtained, when pressure and temperature gradients are simultaneously present in the porous medium. It was concluded that the negative enrichment effect is due to "parasitic," inverse temperature gradients existing in the vessels. As long as the porous medium was connected directly to the working volumes of gas, which were held at a definite temperature by carefully thermostating the entire vessel, only a positive enrichment effect was obtained. The negative enrichment effect was observed experimentally only on removing the thermostats from the vessels. (TTT)

16492 SOLUTION OF THE EQUATIONS FOR THE OPERATION OF A COUNTER-CURRENT ION-EXCHANGE COLUMN FOR THE CASE OF ISOTOPE SEPARATION. N. I. Nikolaev. Zh. Fiz. Khim., 37: 44-51(Jan. 1963). (In Russian)

The derivation and solution of an equation for the operation of a countercurrent ion exchange column were achieved for stationary state conditions under the assumption of internal diffusion and external diffusion exchange kinetics. Expressions were obtained for the HETP. Satisfactory agreement was found between experimental and theoretical HETP values. (auth)

16493 THE ISOTOPE EFFECT ON HYDROGEN ELECTRODES. Gerald Philip Lewis. Thesis, Brooklyn, Polytechnic Inst., 1962. 234p.

The electrochemical hydrogen isotope separation at cathodic and anodic electrodes was studied for the purpose of understanding reaction rate mechanisms and providing data for a proposed heavy water enrichment plant. The dependence of the separation factor, S, on: the cathode material, the cathode surface (porous vs smooth electrodes), the cathode potential, and the cathode temperature was studied by analysis of evolved electrolysis gases. Hydrogen and deuterium electrochemical oxidation rates were studied with a platinized platinum rotating disk electrode. This technique allowed the separation of diffusion effects from the ionization currents, and enabled the maximum kinetic rates of ionization to be determined. The relative rates of hydrogen and deuterium oxidation were determined experimentally with microporous large area diffusion electrodes, as used in fuel cells. The hydrogen was found to oxidize between 1.2 and 1.6 times faster than deuterium. Calculations were made for a proposed heavy water enrichment plant. This electrochemical process utilizes hydrogen anodes and cathodes in each stage. The power costs are considerably less than for any known electrochemical process. The process involves recycle of hydrogen gas and is therefore not dependent on a hydrogen supply. A preliminary cost of $29/lb of product was calculated. It is probable that optimum conditions based on a complete economic analysis of the process will further decrease the cost for heavy water production. (M.P.G.)

16494 INCREASING THE HEAVY HYDROGEN CONTENT OF HYDROGEN. Gustav Schaurer and Albert Heinzel (to Badische Anilin- and Soda-Fabrik Aktiengesellschaft). British Patent 919,876. Feb. 27, 1963. Priority date Nov. 18, 1959, Germany.

A process for increasing the heavy hydrogen content in hydrogen is described. A mixture of hydrogen and nitrogen is passed over a catalyst for ammonia synthesis. The ammonia formed is separated from the gases and replaced by an equivalent amount of hydrogen and nitrogen gases. This process is separated at least nine times. (C.E.S.)

16495 IMPROVEMENTS IN AND RELATING TO ULTRACENTRIFUGES FOR THE SEPARATION OF GASES. (to Reactor Centrum Nederland). British Patent 921,350. Mar. 20, 1963. Priority date, Mar. 17, 1960, Netherlands.

An ultracentrifuge is designed for the separation of gaseous isotopes. The ultracentrifuge comprises a tubular rotor mounted for rotation in a casing, its interior forming a separation chamber. The rotor is open at one end and the separation chamber bounded at the open end by the casing, in order to induce a gas whirl transverse to the rotor rotation. (D.L.C.)

16496 PROCESS AND APPARATUS FOR CONTROLLING COUNTER-CURRENT ELECTRO-MIGRATION APPARATUS. Marius Chemla (to Commissariat à l'Énergie Atomique).

British Patent 921,366. Mar. 20, 1963. Priority date, Apr. 3, 1959, France.

A process and apparatus for carrying out countercurrent electromigration separation of isotopes in molten salts are described for redissolving the metallic deposit of the slowest isotope which tends to form near the cathode. The process comprises adding a substance to the molten bath, interrupting the electrolysis to permit the deposit to react with the added substance and thereby redissolve, and starting the electrolysis again when the potential difference returns to normal. In the case of separation of lithium isotopes in fused lithium bromide, the added substance is bromine. (D.L.C.)

16497 ISOTOPIC EXCHANGE IN THE PRESENCE OF A NONVOLATILE CATALYST. Bertrand Lazard and Jean-Marie Lerat (to Commissariat à l'Énergie Atomique and Houillères du Bassin du Nord et du Pas-de Calais). Canadian Patent 656,855. Jan. 29, 1963. Filed Sept. 14, 1960.

A process is described for separating deuterium from hydrogen by exchange with liquid NH_3. Accumulation of alkaline-earth amide catalyst in the equipment is prevented by the special arrangement of the process. The non-volatile catalyst is concentrated by evaporation of NH_3 in the gas-liquid contact zone. In the process described here, make-up NH_3 containing the normal concentration of catalyst is added before the exchange, and a like amount is withdrawn immediately after exchange so that the concentration of catalyst in the liquid NH_3 phase is prevented. The arrangement of a closed loop and associated equipment for carrying out the process is described. (T.R.H.)

16498 IMPROVEMENTS IN CELLS FOR SEPARATING ALKALI-METAL ISOTOPES BY ELECTROMIGRATION (to Compagnie de Saint-Gobain). French Patent 1,269,742. July 10, 1961. Filed July 6, 1960.

The cell for separating alkali metal isotopes by countercurrent electromigration in a molten salt is provided with superheating zones, situated at the extremities of the diaphragm which communicate with the anode and cathode compartment. Thus the generation of gas bubbles within the diaphragm is prevented. (NPO)

16499 METHOD OF SEPARATING CHEMICAL BODIES OF DIFFERENT MOLECULAR MASSES. George Claude (to Société Anonyme pour l'Etude et l'Exploitation des Procédés). French Patent 1,273,988. Sept. 11, 1961. Filed Sept. 9, 1960.

The patent relates to a diffusion process in which a solution containing salts of different molecular masses is atomized into an oblong flame with a laminar flow pattern, the flame being enveloped by a cold wall on which a part of the salts is redeposited. It is stated that the ratio of the components in the deposit differs from the ratio in the initial solution. The process may be applied for the separation of Li isotopes, the separation factor being 1.054 to 1.064. (NPO)

16500 METHOD FOR REGENERATING ALKYLAMIDE CATALYZERS WHICH HAD BEEN USED FOR ENRICHMENT OF DEUTERIUM BY ISOTOPIC EXCHANGE BETWEEN AMMONIA AND HYDROGEN. Grégoire Dirian and Henri Sack (to Commissariat à l'Énergie Atomique and Houilléres du Bassin du Nord et du Pas-de-Calais). German Patent DAS 1,142,344. Jan. 17, 1963. Filed Aug. 3, 1960.

Isotopic exchange between ammonia and hydrogen is an excellent method for enriching deuterium with the help of catalyzers in such a way that only the alkali metal, which is part of the amide, is regenerated; the hydrogen atoms of the amide are excluded from the regeneration process. The method comprises the steps of electrolysing the mixture of ammonia and amide that has been enriched in deuterium in a first electrolytic cell with a mercury cathode, of electrolysing in a second electrolytic cell the alkali amalgam resulting from the electrolysis in the first cell, the alkali amalgam being the anode, in the presence of ammonia of a low content of deuterium, and of transforming the alkali dissolving in the ammonia while being electrolysed in the second cell into the amide by contacting it with catalytic means in a separate cell. The method can be performed continually. It is of advantage that the alkali metal should not be handled as a dangerous, isolated and separate member. (Gmelin Institute)

16501 SEPARATION OF DEUTERIUM FROM HYDROGEN. Harry K. Orbach and Robert C. Oliver (to Fluor Corp., Ltd.). U. S. Patent 3,081,156. Mar. 12, 1963. Filed Apr. 8, 1960.

A process for separating D_2 from H_2 containing a very small amount of D_2 is described which is based on the different vapor pressures of alkali metal hydrides and deuterides. The process comprises reacting the H_2-D_2 mixture with molten alkali metal at 0.5 to 10 atm to form alkali metal hydride, separating the hydride from the D_2-enriched gaseous residue, reducing the pressure and heating the hydride to effect dissociation, separating the molten alkali metal, and recirculating the metal for reaction with the H_2-D_2 mixture. (D.L.C.)

MATHEMATICS AND COMPUTERS

Refer also to abstracts 16425, 16429, and 16878.

16502 (ANL-6560) RESULTS OBTAINED FROM THE FRICKE DIFFUSION KINETICS CODE. Erwin H. Bareiss, Cynthia Chamot, and Hugo Fricke (Argonne National Lab., Ill.). Sept. 1962. Contract W-31-109-eng-38. 58p.

The Diffusion Kinetics codes described previously in ANL-6556 were used to study hypothetical reactions of free radicals produced by passing α rays and γ rays through aqueous solutions. Tables and graphs of results are given for about 200 cases run on the IBM 704 with various parameter combinations. Intermediate as well as final concentrations are given for some γ-ray cases. (auth)

16503 (BLG-134) HET VERTRAGINGSAPPARAAT, TYPE II. EEN BIJDRAGE TOT DE ANALOOG-REKENINSTALLATIE. (The Delay Apparatus, Type II. A Contribution to the Analog-Computer Installation). L. Boes (Brussels. Centre d'Étude de l'Énergie Nucléaire). Mar. 1962. 59p.

Some problems of reactor dynamics treated on the analog computer of the CEN require the simulation of a pure time lag by means of a delay unit. Such a unit is described. Its principle is based on the transformation of a function $f(t)$ into a function $f(t-\tau)$ using a binary system. The delay time τ can be servo-controlled by a variable of the problem simulated on the computer. The possible errors are discussed, and some examples are given. (auth)

16504 (LAMS-2845) COMPUTER DATA PROCESSING SYSTEM. PROJECT ROVER, 1962. Francis Narin (Los Alamos Scientific Lab., N. Mex.). Jan. 15, 1963. Contract W-7405-eng-36. 175p.

A system was created for processing large volumes of data from Project ROVER tests at the Nevada Test Site. The data are compiled as analog, frequency modulated tape, which is translated in a Packard-Bell Tape-to-Tape converter into a binary coded decimal (BCD) IBM 7090 computer input tape. This input tape, tape A5, is processed on the 7090 by the RDH-D FORTRAN-II code and its 20 FAP and FORTRAN subroutines. Outputs from the 7090 run are tapes A3, which is a BCD tape used for listing on the IBM 1401 input-output computer, tape B5 which is a binary tape used as input to a Stromberg-Carlson 40/20 cathode ray tube (CRT) plotter, and tape B6 which is a binary tape used for permanent data storage and input to specialized subcodes. The information on tape B5 commands the 40/20 to write grids, data points, and other information on the face of a CRT; the information on the CRT is photographed on 35 mm film which is subsequently developed; full-size ($10'' \times 10''$) plots are made from the 35 mm film on a Xerox 1824 printer. The 7090 processes a data channel in approximately 4 seconds plus 4 seconds per plot to be made on the 40/20 for that channel. Up to 4500 data and calibration points on any one channel may be processed in one pass of the RDH-D code. This system has been used to produce more than 100,000 prints on the 1824 printer from more than 10,000 different 40/20 plots. At $6.00 per minute of 7090 time, it costs $1.60 to process a typical, 3-plot data channel on the 7090; each print on the 1824 costs between 5 and 10 cents including rental, supplies, and operator time. All automatic computer stops in the codes and subroutines are accompanied by on-line instructions to the operator. Extensive redundancy checking is incorporated in the FAP tape handling subroutines. (auth)

16505 (ORNL-3399) AN ALGOL 60 SYNTAX CHECKER FOR THE IBM 7090 COMPUTER. Marjorie P. Lietzke (Oak Ridge National Lab., Tenn.). Mar. 21, 1963. Contract W-7405-eng-26. 28p.

A syntax checker was designed based on the syntax of Algol as previously described. It was desirable to design the syntax checker as a set of mutually recursive processors tied together by building blocks which perform certain bookkeeping functions. Because of the recursive nature of the language and of the syntax checker, the problem of recovery after an error required much attention. A method was devised which permits most programs to be checked completely despite errors. The syntax checker was implemented for the IBM 7090 as a part of the SHARE ALGOL processor, and has operated very satisfactorily. (auth)

16506 (SCTM-251-62(24)) CODING OBJECTS FOR SELF-ORGANIZATION. George R. Wilde (Sandia Corp., Albuquerque, N. Mex.). Dec. 1962. Contract [AT(29-1)-789]. 26p.

The successful application of coding for self-organization on a molecular level in the reproduction and growth of biological organisms leads to speculation on applying a similar coding scheme to a macroscopic system. Results of an experimental and theoretical study into the feasibility of using magnetically coded cubes, subjected to a somewhat random motion, to form a self-organizing system are presented. It was concluded that if cube motions were made fairly independent, and if sufficient identically coded cubes were present, such a system should be practical. (auth)

16507 (TID-18116) FORTRAN SNG CODE. NAA Program Description. Barbara Lemke (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 28, 1959. Contract [AT(11-1)-Gen-8]. 18p.

A translation of an ANL code is presented which uses a 32K-709 without a drum, no sense switches, and only off-line input-output. The program must be used in the NAA Load and Go Fortran systems. (J.R.D.)

16508 (TID-18236) TECHNICAL PROGRESS REPORT. PART I. HIGH-SPEED COMPUTER PROGRAM. PART II. CIRCUIT RESEARCH PROGRAM. PART III. SWITCHING THEORY. PART IV. DATA REDUCTION METHODS. PART V. IBM 7090-1401 SYSTEM. PART VI. INSTRUCTIONAL USE OF THE IBM 7090-1401 SYSTEM. PART VII. GENERAL LABORATORY INFORMATION. (Illinois. Univ., Urbana. Digital Computer Lab.). Jan. 1963. Contract AT(45-1)-415. 43p.

A report on the operation and use of the IBM-7090-1401 computers system at the Univ. of Illinois is presented. The current status of other high speed computer programs and computer research work is discussed. (H.G.G.)

16509 EXPLICIT SOLUTIONS OF PARTIAL DIFFERENCE EQUATIONS AND RANDOM PATHS ON PLANE NETS. Edward M. Keberle (Argonne National Lab., Ill. and New York Univ., New York). J. Math. Anal. Appls., 6: 1-32(Feb. 1963).

The problem of a random walk executed on a plane Bravais net with trapping boundaries is discussed. Explicit solutions are found for the six-connected triequiangular

net. The analytical solutions are approximate for finite arrays but become exact in certain limiting cases. Numerical solutions are obtained for finite six-connected nets by means of a high speed digital computer. It is found that the analytical solutions are good approximations to the exact solutions. A rapidly converging overrelaxation procedure for solving the linear algebraic equations is developed. General solutions are obtained for random paths on complex lattices. Connections between these solutions and the Green's function solution for the corresponding partial differential equations are discussed. (auth)

16510 THE NONISENTROPIC PERTURBATION OF A CENTERED MAGNETOHYDRODYNAMIC SIMPLE WAVE. Roy M. Gundersen (Univ. of Wisconsin, Madison and Illinois Inst. of Tech., Chicago). J. Math. Anal. Appls., 6: 86-97 (Feb. 1963).

After linearization of the governing equations of the one-dimensional nonsteady motion of an ideal, inviscid, perfectly conducting monatomic compressible fluid, subjected to a transverse magnetic field, in the neighborhood of a centered simple wave flow, weakly nonisentropic perturbations are considered. The solution for the first order terms is given by quadratures. (auth)

16511 THE GENERALIZED PATH VARIABLE METHOD. Herbert F. Budd (Ecole Normale Superieure, Paris). J. Phys. Soc. Japan, 18: 142(Jan. 1963). (In English)

The exact solution of the Boltzmann equation was given in the relaxation time approximation for general external fields and a general band structure. The Boltzmann equation was considered with a general collision operator and its solution was obtained by an iteration of the solution in the relaxation time approximation. (C.E.S.)

16512 ON THE MULTIPLICITY OF AN IRREDUCIBLE REPRESENTATION IN A DIRECT PRODUCT OF IRREDUCIBLE REPRESENTATIONS OF SU(3). H. Goldberg (Israel Atomic Energy Commission Labs., Rehovoth). Nuovo Cimento (10), 27: 532-5(Jan. 16, 1963). (In English)

An irreducible representation of U(3) is characterized by a triplet of numbers $[\lambda_1\lambda_2\lambda_3]$ and does not decompose when restricted to SU(3) but becomes equivalent to $[\lambda_1 + \partial_1\lambda_2 + \partial_1\lambda_3 + \partial]$. When $\lambda_3 \geq 0$, $[\lambda_1\lambda_2\lambda_3]$ determines a Young diagram. The relation between $[\lambda_1\lambda_2\lambda_3]$ and the irreducible representations of SU(3) $(\alpha_1\beta)$ may be used to get a closed formula for the number of times a representation (α_3,β_3) appears in a direct product $(\alpha_1\beta_1) \times (\alpha_2\beta_2)$. (C.E.S.)

16513 NON-ABELIAN GAUGE FIELDS. LORENTZ GAUGE FORMULATION. Julian Schwinger (Harvard Univ., Cambridge, Mass.). Phys. Rev., 130: 402-5(Apr. 1, 1963).

Non-Abelian vector gauge theory is given a first-order Lorentz gauge formulation and then transformed into the radiation gauge. The result agrees with the independently constructed radiation gauge theory. There is a brief discussion of the axial gauge. (auth)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstracts 16941, 17442, 17444, 17445, and 17446.

16514 (ARF-B6007-1) DISPERSION-STRENGTHENED VANADIUM ALLOYS. Bimonthly Report No. 1, December 14, 1962–February 13, 1963. F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Mar. 12, 1963. Contract N600(19)59567. 16p. (AD-298937)

Dispersion-strengthening mechanisms are under investigation in alloys based on the Nb–V system for the purpose of improving stress-rupture properties. Ten compositions containing small C additions in combination with Hf or Zr were prepared by nonconsumable-electrode arc melting. Powder metallurgy preparation of alloys containing dispersed refractory particles is also under investigation. Minus 325 mesh powders of a V–Nb–Ti alloy were produced by the hydride process; the sintered compacts were over 90% of theoretical density and possessed a relatively high degree of compressive ductility at room temperature. (auth)

16515 (DMIC-Memo-165) REVIEW OF USES FOR DEPLETED URANIUM AND NONENERGY USES FOR NATURAL URANIUM. (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 1, 1963. 25p.

Concern regarding large stocks of depleted uranium led to initiation of several studies designed to find possible uses. Properties of uranium and uranium alloys which might permit applicability to new uses are discussed. Some uses for depleted uranium under present investigation are cathodic protection, alloy addition to steel, bearings, catalyst for petroleum refining, heavy media for mineral separation, and catalyst for automobile exhaust deoxidation. The successful utilization of uranium for many uses shows great promise, but usage is not likely to equal estimated production of 20,000 tons of depleted uranium per year. More research is needed to alleviate this serious problem. Further extension of present uses can be accomplished by public education, relaxation of licensing restrictions, and downward adjustment of government-controlled pricing. (H.G.G.)

16516 (GA-3866) INVESTIGATIONS OF CARBIDES AS CATHODES FOR THERMIONIC SPACE REACTORS. Quarterly Progress Report for the Period Ending November 30, 1962. L. Yang, A. F. Weinberg, F. D. Carpenter, R. G. Hudson, C. W. Savery, D. E. Johnson, and J. Lindgren (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Contract NAS 3-2532. 92p.

Two exploratory runs of less than 24-hr duration were carried out on a nominal 90UC–10ZrC sample under a cesium pressure of about 1.6 torr in an all-metal cell to gain preliminary information on the rate of vaporization. There was uncertainty in the pyrometric reading of the surface temperature of the sample in cesium vapor. The life-test cell used for determining emission stability of UC–ZrC was designed and the first cell is about 75% completed. In addition two cell operating stations and their associated electronic instrumentation are being assembled and a high-vacuum station for outgassing the cell was set up. The effect of density on the rate of vaporization and electron emission of UC–ZrC in vacuum was studied. Measurements were completed on four nominal 90UC–10ZrC samples and two nominal 30UC–70ZrC samples of various densities. The low-density samples (86 to 92.5% theoretical density) emit about the same but the emission is definitely higher than that of samples of 97.5% theoretical density. The difference, however, decreases as temperature is increased. Measurements were completed on three nominal 90UC–10ZrC samples of various densities (86 to 97.5% theoretical density) and were started on a nominal 30UC–70ZrC sample of 92.5% theoretical density. The rate of vaporization increased as the density of the sample was decreased. An all-metal cell was designed and is now being fabricated. This cell will make it possible to study the rate of vaporization of UC–ZrC in cesium plus cesium halide vapor at high temperatures. A thermionic emission microscope suitable for the study of the controlling factors for the emission of carbide cathodes is being fabricated. A high-temperature furnace is being fabricated which can be used together with an Instron Universal Tester to study the rupture strength of carbides by the four-point loading method. Essential features of the design of the carbide capsule were firmed up and pertinent thermal and neutronic calculations needed for specifying fuel loading were made. Thermal cycling of the essential parts of the capsule and thermal mock-up of the capsule were carried out in the laboratory. Vacuum emission and its variation with thermal history were measured on a hot-pressed nominal $UMoC_2$ sample. Diffusion between UC and Ir, Re, and W-26Re alloy was studied at 1800°C. Liquid-phase formation was observed at the UC–Ir interface, and reaction layers and products were detected at the UC–Re and the UC-(W-26Re) interfaces. The compatibility of UC with tungsten formed by the thermochemical decomposition of WF_6 in hydrogen is being studied at 2073°K by monitoring the vacuum emission of the tungsten deposited around a UC wafer. Preparation of submicron-size UZrC powder by hydriding U–Zr alloy foils followed by carburization in CH_4 is under investigation. Cold-pressing and sintering of UC–ZrC bodies were studied; single-phase materials (86 to 93% dense) of 30 to 90 mol % UC were consistently obtained by using –325 mesh powder prepared by grinding the arc-melted UC–ZrC buttons. UC–ZrC bodies of UC concentration graded from 90 mol % at one end to 30 mol % UC at the other end were successfully prepared. Tungsten formed by thermochemical decomposition of volatile tungsten compounds is being studied as the emitter and clad for carbide fuels. A vacuum hot press was assembled for the hot-pressing of carbide samples under clean conditions. (auth)

16517 (HW-SA-2872) UTILIZATION OF PLUTONIUM FOR SOME SPECIAL REACTOR APPLICATIONS. P. L. Hofmann (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 5, 1963. Contract AT(45-1)-1350. 39p.

A number of possible applications of plutonium as a power reactor fuel were reviewed. While the discussion was confined primarily to the physics statics of the problem, the potential of plutonium fuel for a large variety of applications is shown. (auth)

16518 (LADC-5380) PREDICTION OF SOLID SOLUBILITY IN METALLIC ALLOYS. James T. Waber, Karl

Gschneidner, Jr., Allen C. Larson, and Margaret Y. Prince (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 34p.

The original graphical method proposed by Darken and Gurry for predicting which elements are soluble in a given element was slightly modified and was used to predict terminal solubilities in 1455 known binary combinations. The modified Darken and Gurry method had a reliability of 61.7% in predicting extensive solid solubility (>5 at. %) and of 84.8% in predicting limited solid solubility (<5 at. %), an overall reliability of 76.6%. The Hume-Rothery size-effect criterion was 50.1% reliable in predicting extensive solid solubility, only slightly better than a purely random choice, and 90.3% reliable for predicting limited solid solubility, an overall reliability of 67.6%. (auth)

16519 (LM-TAB-21) LIQUID METALS TECHNOLOGY ABSTRACT BULLETIN, SEPTEMBER 1962–FEBRUARY 1963. (MSA Research Corp., Callery, Penna.). 20p.

An abstract bibliography on current (9/62 to 2/63) liquid metals technology literature is presented. Forty-nine abstracts of published literature in this field are included. (H.G.G.)

16520 (MAB-189-M) EVALUATION PROCEDURES FOR SCREENING COATED REFRACTORY METAL SHEET. (National Research Council. Materials Advisory Board). Feb. 15, 1963. 15p. (AD-298015)

A discussion of the evaluation procedures used to select and recommend advanced-development coatings for metal sheets which are being produced under the refractory metals sheet program, such that the coated sheet will have maximum oxidation resistance combined with least impairment to its mechanical properties, is presented. (H.G.G.)

16521 (NAA-SR-Memo-2974) URANIUM–MOLYBDENUM ALLOY FUEL COSTS. R. E. Aronstein (Atomics International Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 11, 1958. Contract [AT-11-1-GEN-8]. 18p.

Fuel costs of an HNPF reactor using U–Mo alloy fuels and a 19 rod UO_2 cluster fuel element with 0.5-in. dia fuel slugs are presented. The two alloys considered were U–3 wt % Mo and U–10 wt % Mo. Fuel costs for the U–Mo alloys are higher than the UO_2 fuel costs, due primarily to the lower permissible peak burnups (5000 Mwd/t-alloy for 3 wt % Mo and 10,000 Mwd/t-alloy for 10 wt % Mo vs 20,000 Mwd/t–UO_2 for UO_2). Tables showing comparison fuel costs, fuel element life, and average burnups for U–Mo alloys are included. (H.G.G.)

16522 (NCSC-2663-10) URANIUM INTERSTITIAL PHASES. Quarterly Progress Report. Robert F. Stoops and John V. Hamme (North Carolina State Coll., Raleigh). Dec. 1962. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(40-1)-2663. 22p. (EURAEC-531)

Chemical analyses and x-ray-diffraction patterns were obtained for furnace-cooled products which were reacted at 1800°C in flowing He atmospheres and in vacuums of approximately 0.5 μ Hg. The chemical and x-ray analyses show that up to 25 at. % of the C may be replaced by O_2 substitutionally. A least squares treatment of the data indicate a lattice parameter of 4.964Å for UC and a lattice parameter of 4.953Å for the solid solution of composition $U(C_{0.75}O_{0.25})$. A tentative phase diagram is given showing the phase relationships found in the furnace-cooled products. A range of C solubility in UC was indicated by a lattice parameter of 4.972Å in an x-ray-diffraction pattern of one specimen. This range of C solubility was not indicated on the tentative phase diagram as it has not been substantiated by chemical analysis. A C deficient UC phase apparently does not exist under the conditions of these experiments. (auth)

16523 (NP-12632) DEFENSE METALS INFORMATION CENTER SELECTED ACCESSIONS. Patricia B. Plate (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Feb. 1963. Contract AF33 (616)-7747. 57p.

One hundred one references with abstracts are included for documents and journal articles pertaining to metal studies. Author, subject, and DMIC numerical indexes for the abstracts are provided. (D.C.W.)

16524 (NUMEC-P-103) DEVELOPMENT OF PLUTONIUM-BEARING FUEL MATERIALS. Progress Report, October 1 through December 31, 1962. K. H. Puechl (Nuclear Materials and Equipment Corp., Apollo, Penna.). Contract AT(30-1)-2389. 44p.

Powder characteristics of PuO_2 prepared by oxalate and hydroxide precipitation were determined. Studies of sintered UO_2–35 wt % PuO_2 prepared by coprecipitation revealed that the optimum sintering time is between 1 and 16 hrs. Good spherical shapes were obtained by use of plasma torch on UO_2–20 wt % PuO_2 mixtures. Oxalate-precipitated PuO_2 exhibited good filtration characteristics. Sintering study results using UO_2–35 wt % PuO_2 indicate that this composition does not achieve as high density as those mixtures containing less Pu. The apparatus for measuring thermal conductivity of poor conductors at high temperatures is in operation. Composite pellets of UO_2–PuO_2 incorporating cladding and dispersion element materials are being pressed and sintered to test for possible reactions. Physics studies on near-thermal reactors are being extended to higher Pu loadings. (J.R.D.)

16525 (NYO-9736) INVESTIGATIONS OF RADIOACTIVE FUEL-BEARING GLASSES. Annual Report, April 1, 1961–March 31, 1962. P. A. Lockwood (Owens-Corning Fiberglas Corp. Technical Center, Granville, Ohio). June 30, 1962. Contract AT(30-1)-2489. 48p.

A series of high urania-content glasses were fiberized and examined for high-temperature strength properties. One glass, RX360 containing 60% U_3O_8 by weight, had better high-temperature tensile properties than any glass previously reported. It was observed that many of the glasses studied separated into immiscible phases and that the fiberizable glass phase had lower U_3O_8 content than the base compositions. A physical analysis of crystal structures of the devitrification products from the nuclear fuel glasses indicated that most of the crystals consisted of uranium oxide in a reduced state. By adding O_2 to molten glass, it was possible to eliminate most of this devitrification. By elimination of crystals, the fiberizing of the glass was more uniform and the glasses produced had more consistent physical properties. (auth)

16526 (ORNL-TM-481) INFLUENCE OF CO–CO_2 ENVIRONMENTS OF THE CALIBRATION OF CHROMEL-P–ALUMEL THERMOCOUPLES. H. E. McCoy, Jr. (Oak Ridge National Lab., Tenn.). Mar. 28, 1963. Contract [W-7405-eng-26]. 22p.

The thermal output of Chromel-P–Alumel thermocouples decreases as a result of exposure to CO–CO_2 mixtures at elevated temperatures. These calibration changes are significantly greater than those observed for these thermocouple materials in air. In CO_2-rich mixtures, the negative drift is due primarily to the loss of chromium

from solution in the Chromel-P wire as a result of oxidation. In CO-rich mixtures, carburization and oxidation remove chromium from solution, thus causing the thermal electromotive force of the thermocouple to decrease. (auth)

16527 (USBM-U-1001) METALLURGICAL QUARTERLY PROGRESS REPORT NO. 17 FOR THE PERIOD OF OCTOBER 1–DECEMBER 31, 1962. (Bureau of Mines. Albany Metallurgy Research Center, Ore). Contract AT (11-1)-599. 25p.

Descriptions of six projects concerning the metallurgy of alloys are included in this metallurgical progress report for Oct. to Dec. 1962. They are: an investigation of the possibility of producing alloys of the rare earth metals with properties conducive to use in nuclear power reactors; determination of Hf–C, Hf–Ir, and Hf–V phase diagrams; evaluation of selected physical and mechanical properties of Th alloyed with rare earth elements; development of homogeneous alloys of rare earth oxides and refractory metals with improved mechanical and oxidation-resistant properties; development of methods for producing ductile bonds in Nb, Ta, or their alloys with emphasis on diffusion bonding as induced by pressure, heat, ultrasonics, and other special techniques; and determination of conditions which will provide optimum cooling of water-cooled crucibles used for consumable-electrode arc melting. (H.G.G.)

16528 (EURAEC-126) PREPARATION AND IRRADIATION OF U–UC CERMETS AND STOICHIOMETRIC UC. Quarterly Report No. 2, March–June 1961. D. Whitwham, J. Boghen, and J. Herenguel (Trefileries et Laminoirs du Havre, France). June 13, 1961. Work Performed under United States–Euratom Joint Research and Development Program. 17p. A translation.

Annex to EURAEC-125.

Production of compact rods of UC from mixtures of uranium and graphite powders is discussed. The process of manufacture is divided into two stages: sintering-extrusion of the powder mixture in order to produce a rod of high density, followed by a heat treatment to produce the UC, whereby the free graphite is completely eliminated. Previous experience in sintering-extruding indicates that the best method is to proceed in successive steps from mixtures of low graphite content (0.5% by weight) until the theoretical content (4.8%) of the pure monocarbide is reached. When the degasification is carried far enough, a satisfactory compactness is obtained for pure uranium with an extrusion coefficient of ~4 at temperatures between 500 and 600°C. These conditions were adopted for the tests on the U–C mixtures with the graphite content limited to two levels, 0.5 and 2.0% by weight. The presence of graphite particles in the extruded rod up to 15 μ does not seem obnoxious in any manner. They are totally absorbed after a heat treatment of 1000°C. (H.G.G.)

16529 (EURAEC-509) PRODUCTION OF ZIRCONIUM ALLOY POWDERS BY IGNEOUS ELECTROLYSIS — PRELIMINARY STUDY. Special Report No. 7. Final Report, December 16, 1961 to July 15, 1962. (Brussels. Centre d'Étude de l'Énergie Nucléaire and Societe Belge pour l'Industrie Nucléaire, Brussels). Work Performed under United States–Euratom Joint Research and Development Program. Contract 27-60-7RDB. 37p. A translation.

Efforts to determine the possibilities of obtaining the co-depositing of Zr and Nb from molten electrolytes containing NaCl, ZrF_4, and $KNbF_7$ are described. The testing temperature was fixed at 900°C to take advantage of the great mixability of Nb and Zr in the solid state beyond 862°C. The electrolysis tests confirmed the cathodic polarization curve indications that it is possible to obtain alloying powders of variable composition by effecting such electrolysis with fused mixtures containing the above-mentioned salts, characterized by an Nb/Zr molar ratio of 1/3. In all cases, Nb is deposited preferentially to Zr. It is not feasible to deposit the alloy from $NaCl-ZrF_4-K_2NbF_7$ mixtures characterized by an Nb/Zr molar ratio higher than 1/3. (H.G.G.)

16530 (JPRS-18277) CERTAIN PROBLEMS IN THE CARBOTHERMIC REDUCTION OF NIOBIUM PENTOXIDE. P. V. Gel'd and G. P. Shveykin. Translated from Izv. Akad. Nauk SSSR, Otd. Tekhn. Nauk, Met. i Toplivo, No. 1, 44-9(1959). 12p. (OTS-63-21384)

Niobium carbide forms easily during the action of Nb_2O_5 with C. Hence, to obtain the metal, the process is accomplished by the action of oxides with the carbide. Up to 1250°C, the interaction proceeds slowly, but at 1350°, a partial reduction occurs (~17%). The second stage (1500°C) results in 43% reduction and further reduction occurs at 1600°C. At 1750 to 1800°C and pressure of 5×10^{-3} mm Hg, a niobium sponge containing 98.8 to 99.8% Nb can be produced. An increase in temperature and a drop in pressure results in an improvement of product quality. Results indicate that metallic Nb is obtained most advantageously through the use of an oxide-carbide mixture. (H.G.G.)

16531 MARTENSITE TRANSFORMATION OF LOW CARBON AUSTENITE 18-10 STEEL COLD WORKING AND FLOW AT VERY LOW TEMPERATURES. Daniel Mugnier and Louis Weil (CNRS, [Paris] and Université, Grenoble, France). Compt. Rend., 256: 153-5(Jan. 2, 1963). (In French)

It was previously shown how the plastic transformation at very low temperatures was responsible for the austenite → martensite transformation by formation of slip planes and of an instable intermediary compact hexagonal phase. It is shown that, in a general way, the quantity of martensite formed at constant temperature is an unequivocal function of the plastic deformation. (tr-auth)

16532 INDUSTRIAL USE OF LESS COMMON METALS. Fonderia, 11: 127-8(Mar. 1962). (In Italian)

Electron beam drip melting, casting, and centrifugal melting of Mo, Ta, Nb, and W is discussed. Consideration is also given to their fragility and oxidation resistance. (P.C.H.)

16533 THE TECHNOLOGY OF ZIRCONIUM EXTRACTION. Rudolf Proft. Freiberger Forschungsh., 64B: 73-89(1962). (In German)

Zirconium is extracted by fusion of ZrO_2 ores, separation of Hf by liquation, and refining by the van Arkel, Kroll, and Ram processes. (P.C.H.)

16534 LATTICE DEFECTS AND THE SINTERING OF OXIDES. L. C. F. Blackman. Ind. Chemist, 39: 23-6(Jan. 1963).

A literature survey is presented on the effects of additives and sintering atmosphere on the sintering of refractory oxides. The limitations of the described studies are discussed. It is concluded that complete characterization of such parameters as impurities, crystallite size, non-stoichiometry, and phase homogeneity is necessary in such studies. (D.L.C.)

16535 ADVANCES IN LIQUID METAL TECHNOLOGY. B. R. T. Frost (Atomic Energy Research Establishment,

Harwell, Berks, Eng.). J. Nucl. Mater., 7: 109-24(Nov. 1962). (In English)

A review is presented of the progress made since 1958 in the study of metallurgical and chemical problems in the use of liquid sodium and other liquid metals as reactor coolants. The studies reviewed cover corrosion, wetting, and physical properties. Areas requiring further study are outlined. (D.L.C.)

16536 ORIENTATION OF OXIDE FILMS FORMED ON GAMMA PHASE URANIUM ALLOYS. J. A. O'Rourke and J. T. Waber (Los Alamos Scientific Lab., N. Mex.). J. Nucl. Mater., 7: 125-32(Nov. 1962). (TID-6011). (In English)

Highly oriented oxide films were found to form when two cold-rolled, gamma-phase (7 wt % Mo and 10 wt % Nb) alloys of uranium were oxidized in water vapor. Dodecahedral planes of UO_2 were formed parallel to the specimen surface, as in unalloyed uranium. An epitaxial relationship between the UO_2 and the niobium alloy could be deduced. The relevance of this work to Chirigos' theory of corrosion cracking in such gamma phase alloys is discussed. (auth)

16537 REACTION BETWEEN BERYLLIUM AND URANIUM MONOCARBIDE. J. F. Murdock (Oak Ridge National Lab., Tenn.). J. Nucl. Mater., 7: 192-6(Nov. 1962). (In English)

The reaction between hot-pressed beryllium and arc-melted uranium monocarbide was studied in the temperature range 700 to 1000°C using A–B type diffusion couples. The carbide used was of two compositions—4.8 and 5.1 wt % C. Reaction occurred throughout the temperature range studied, resulting in a layer of UBe_{13} with a uniformly dispersed precipitate which could not be identified. The reaction was found to be controlled by the diffusion of beryllium in UBe_{13}, with reaction occurring at the UBe_{13}–UC interface. An activation energy of 33,000 cal/mole was determined for the process. (auth)

16538 ARC INITIATION ON HEATED MOLYBDENUM EXPOSED TO A TOROIDAL HYDROGEN DISCHARGE CONTAMINATED WITH IMPURITY GASES. J. T. Maskrey and R. A. Dugdale (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 7: 197-204(Nov. 1962). (AERE-R-3911). (In English)

Earlier work on hot molybdenum exposed to a toroidal hydrogen discharge was extended to investigate the effects of oxygen, nitrogen and neon contamination on arc initiation. It is found that molybdenum treated to be non-arcing in pure hydrogen tends to arc when oxygen or nitrogen is added, in contrast to neon, which does not encourage arcing. The arcing induced by oxygen or nitrogen is attributed to the formation of oxides and nitrides by elemental impurities present in the molybdenum. In the case of nitrogen the effect gradually disappears owing, it is supposed, to the depletion of the impurities responsible in the specimen. Although, under certain conditions, a similar trend is observed for oxygen, the excessive erosion of the molybdenum at high temperatures in the presence of oxygen prevents the achievement of a non-arcing state owing to the continual exposure of material relatively rich in impurities. It is predicted that at low temperatures, where atomic diffusion does not take place, arcing should not be sensitive to oxygen or nitrogen. (auth)

16539 HYDROGEN IN ALUMINUM–TRITIUM AUTORADIOGRAPHY. L. M. Foster, A. S. Gillespie, Jr., T. H. Jack, and W. W. Hill (Aluminum Co. of America, New Kensington, Penna.). Nucleonics, 21: No. 4, 53-5(Apr. 1963).

Techniques are described for incorporating tritium into aluminum from gaseous tritium and tritiated water vapor and for obtaining autoradiographs of tritiated aluminum. Typical autoradiographs that show the kind of structure found in aluminum are given. (D.L.C.)

16540 PROBLEMS IN METAL PHYSICS. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 16, 1-232 (1962). (In Russian)

Thirty-four articles are included on the behavior of crystal defects under thermal and mechanical treatment and irradiation and on their magnetic and electric properties. Equilibrium diagrams of various high-melting alloys were constructed, and their physical properties were analyzed. Separate abstracts have been prepared for six of the more significant articles. (R.V.J.)

16541 EFFECTS OF γ RADIATION ON PROPERTIES OF DEFORMED METALS. I. Ya. Dekhtyar and A. M. Shalaev. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 16, 48-54(1962). (In Russian)

Gamma effects on the microintensity gradient or concentration in 30 to 35 mm long, 0.3 mm thick specimens of Fe–Cr(8, 10, and 12% Cr), Fe–Al(25% at % Al), and U-8 steel were studied at 720, 600 to 1200, and 850°C respectively. (R.V.J.)

16542 CONSTITUTION DIAGRAM OF Fe–C–Hf SYSTEM. V. N. Svechnikov and A. K. Shurin. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 16, 124-7(1962). (In Russian)

Polythermal diagrams were constructed for Fe–C–Hf alloys with constant Hf and variable C contents and with constant C and variable Hf contents. (R.V.J.)

16543 CHROMIUM–NIOBIUM–TITANIUM ALLOYS. V. N. Svechnikov, Yu. A. Kocherzhinskii, V. I. Latyshev, and V. M. Pan. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 16, 128-31(1962). (In Russian)

An isothermal diagram of Cr–Nb–Ti alloy was constructed for 1250°C, and the melting point was found. An additional isotherm was constructed for the liquidus surface at 1680°C. (R.V.J.)

16544 CONSTITUTION DIAGRAM OF Fe–Zr ALLOYS. V. N. Svechnikov and A. Ts. Spektor. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 16, 136-44(1962). (In Russian)

X-ray diffraction, microstructure, thermal, and durametric analyses of 21 specimens of electrolytic iron and iodide zirconium showed two-peaks for alloys with 30% Zr as 1320 and 1325°C (eutectic melting and liquidus point). Another peak was found for alloys with more than 30% Zr at 1480°C. Microstructure studies revealed a two-phase structure for alloys with less than 30% Zr, single-phase for 30 to 34% Zr, and again two-phase for alloys with more than 34% Zr; both phases had identical microhardness corresponding to the intermetallic ϵ'. A new intermediate η phase was studied, and changes in the 35 to 50% Zr $\underline{\epsilon}'$ phase lattice parameters were analyzed. (R.V.J.)

16545 CONSTITUTION DIAGRAM OF $ZrCr_2$–$ZrFe_2$ ALLOYS. V. N. Svechnikov and A. Ts. Spektor. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 16, 145-52(1962). (In Russian)

The constitution diagram of $ZrCr_2$–$ZrFe_2$ indicated two separated solubility regions in alloys with 51% Cr, 4% Fe to 41% Cr, 14% Fe at 1635°C and with 33% Cr, 20% Fe to 5% Cr, 50% Fe at 1625°C. The observed two peritectic regions join at the liquidus-solidus point at 1600°C with 38% Cr, 16% Fe, and 46% Zr. The $ZrCr_2$–$ZrFe_2$ section is quasi-binary. (R.V.J.)

16546 DIFFUSION OF Fe IN Fe–Hf ALLOYS. S. D. Gertsriken, T. K. Yatsenko, and L. F. Slastnikova. Sb. Nauchn. Tr. Inst. Metallofiz., Akad. Nauk Ukr. SSR, No. 16, 158-67(1962). (In Russian)

A constitution diagram for Fe–Hf was constructed, and the maximum Hf diffusion in α iron, equal to 0.2%, was determined by the intersection of the peritectoid horizontal with an extrapolated $\alpha \rightarrow \gamma$ transformation curve. The temperature of transformation, $\alpha + \epsilon \rightarrow \gamma + \epsilon$, was 935 ± 5°C. The maximum Hf diffusion in γ iron is 1.6% at 1330°C. The content of Hf in the iron specimens was ~0.53 wt %. (R.V.J.)

16547 ELECTROLYTIC PRODUCTION OF Ta AND Nb AND THEIR ALLOYS. V. I. Konstantinov and V. M. Amosov. Tsvetn. Metal., No. 8, 72-6(Aug. 1962). (In Russian)

It was shown that electrolytic production of Ta, Nb, and their alloys is superior to the sodium thermal method. Experiments were made using Ta and Nb pentoxides containing up to 0.4 to 0.5% Ti and up to 0.2% Si. (R.V.J.)

16548 PREPARATION OF Ta AND Nb BY REDUCTION OF PENTACHLORIDES WITH HYDROGEN (REDUCTION OF $TaCl_5$). Ya. M. Polyakov, L. A. Nisel'son, and A. N. Krestovnikov. Zh. Prikl. Khim., 36: 25-33(Jan. 1963. (In Russian)

Thermodynamic data for Ta and Nb chloride reduction and equilibrium coefficients at 700 to 2000°K were analyzed and tabulated. High yields of tantalum were observed at 1200 to 1700°K. Experiments on hydrogen reduction of $TaCl_5$ in a tubular device, per 10 min operation with 0.41 to 0.45 molar vapor-gas mixture, at 1200, 1400, and 1600°C and at various H–$TaCl_5$ ratios, showed no temperature effects on tantalum precipitation at concentration ratios up to 0.05 mole $TaCl_5$ per mole of vapor-gas mixture. A maximum yield 14.4 g per mole of mixture was obtained at 1600°C. The yield from $TaCl_5$ reduction on a heated strip element was 9 to 11 g per mole of mixture with 25 to 30% $TaCl_5$ transformation into metal. (R.V.J.)

16549 MOLYBDENUM METAL. New York, Climax Molybdenum Co., 1960. 110p.

Engineering data on Mo are given for its applications, physical and mechanical properties, corrosion and oxidation resistance, fabrication, and analysis. An extensive bibliography is included. (D.L.C.)

16550 THE METAL PLUTONIUM. A. S. Coffinberry and W. N. Miner, eds. Chicago, University of Chicago Press, 1961. 455p.

Thirty-five papers are included; separate abstracts have been prepared for twenty-six. Nine papers were previously abstracted in NSA. (A.G.W.)

16551 THE DISCOVERY OF PLUTONIUM IN THE CYCLOTRON. Glenn T. Seaborg (U. S. Atomic Energy Commission, Washington, D. C.). p.9-12 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

The story of the transuranium elements began in 1934 with the discovery that the neutron irradiation of U produced a number of radioactive substances. A specific search for element 94 began in Dec. 1940 with the bombardment of uranium oxide with 16-Mev deuterons in the Crocker Laboratory cyclotron. The isotope Pu^{238} was identified, and the chemical properties of Pu were studied by the tracer method during 1941 and early 1942. Meanwhile the search for Pu^{239} was successful, and its value as a nuclear energy source was established during the spring of 1941. (A.G.W.)

16552 THE FIRST ISOLATION OF PLUTONIUM. B. B. Cunningham (Univ. of California, Berkeley). p.13-17 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

When, in Dec. 1941, the U. S. government decided on a major effort to produce militarily useful amounts of Pu^{239}, studies of the necessary chemical processing methods had to be started with only the small amounts of Pu produced by cyclotron bombardment. An ultramicrobalance capable of weighing a μg of material to 1% was constructed and calibrated. A series of oxidation-reduction cycles were used to isolate the Pu produced in the cyclotron. The precipitation of the first pure compound of Pu was performed on Sept. 19, 1942, when an excess of NH_4OH was added to a pure carrier-free nitrate solution, producing a green flocculent precipitate of the hydroxide. The precipitate was subsequently converted to the oxide, weighed, and counted for Pu^{239} activity. The half life was computed to be 24,300 years. (A.G.W.)

16553 THE MICROSCALE PREPARATION AND MICROMETALLURGY OF PLUTONIUM METAL. S. Fried (Argonne National Lab., Ill.), E. F. Westrum, Jr., H. L. Baumbach, and P. L. Kirk. p.18-25 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Microchemical and micrometallurgical studies of Pu made during 1943 and 1944 at the Manhattan Project Metallurgical Laboratory operated by the University of Chicago are summarized. Plutonium metal was first produced in Nov. 1943 by reduction of PuF_4 with Ba in a thoria crucible in a high-vacuum microfurnace. Further studies led to development of other reactants and other crucible materials. The ceramic double-crucible system and the experimental reduction technique used are described. The density of Pu metal was determined by a micropycnometric method to be 15.4 ± 0.2 g/cm^3 for Pu produced in ThO_2 crucibles and 17.2 to 21.0 g/cm^3 for Pu produced in BeO crucibles. The difference is now known to be due to phase transformations. (A.G.W.)

16554 PLUTONIUM METALLURGY AT LOS ALAMOS DURING 1943-45. Cyril Stanley Smith (Univ. of Chicago). p.26-35 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Work on Pu metallurgy carried out at Los Alamos during World War II is summarized. The most serious problems were due to the extreme reactivity of the metal and to the existence of five phases between room temperature and the melting point. Cerium sulfide crucibles were used in handling molten Pu, and an impervious coating had to be applied to finished pieces. Large volume changes took place on phase transformation. Physical properties of each phase as they were believed to be in 1945 are listed. (A.G.W.)

16555 PLUTONIUM METALLURGY AT THE ARGONNE NATIONAL LABORATORY. Frank G. Foote (Argonne National Lab., Ill.). p.63-9 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Work at Argonne since 1945 in the field of fast-breeder reactors and efforts to prepare Pu-containing materials suitable for use in thermal reactors are reviewed. Health hazards associated with handling of Pu and methods of hazard control are discussed. Maximum permissible limits in air of natural U, U^{238}, U^{236}, U^{233}, Pu^{239}, Po^{210}, and Ra^{226} are listed. Existing and planned Pu-handling facilities at ANL are described. (A.G.W.)

16556 STUDIES ON PLUTONIUM AT CHALK RIVER. O. J. C. Runnalls (Atomic Energy of Canada Ltd., Chalk

River, Ont.). p.70-8 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

A program of Pu-alloy development was begun at Chalk River in 1951. A method for fabrication of Pu–Al fuel rods for the NRX reactor was developed, and a laboratory for their production was built. Studies of the constitution and fabrication of Pu–Al alloys were made. Other alloys studied less intensively included Pu–Ag and Pu–Be. (A.G.W.)

16557 METALLURGICAL STUDIES ON PLUTONIUM IN GREAT BRITAIN. H. M. Finniston (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.79-83 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Plutonium studies in the United Kingdom started in 1947, and much of the work done in America was repeated. The physical properties were determined and fabrication techniques were studied. In 1952 Pu-alloy fuel elements for experiment Zephyr were prepared. Future programs in regard to Pu are discussed. (A.G.W.)

16558 PLUTONIUM METALLURGY IN FRANCE. E. Grison (Centre d'Études Nucléaires, Paris). p.84-96 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Work with metallic Pu in France began in Jan. 1956. Special equipment for Pu handling is described. Most work was done on Pu–Al alloys. Micrographs illustrating the as-cast microstructures of Al alloys with Pu content from 10 to 50 wt % are shown. (A.G.W.)

16559 CRYSTAL-STRUCTURE STUDIES OF PLUTONIUM METAL. W. H. Zachariasen (Univ. of Chicago). p.99-107 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Available crystal structure information for six phases of Pu is summarized. Temperatures of transition from phase to phase are listed. The principal linear coefficients of thermal expansion of all six phases are tabulated. The metallic radius of Pu and the electron configuration in Pu and other heavy metals are discussed. (A.G.W.)

16560 THE EXAMINATION OF PLUTONIUM METAL BY X-RAY DIFFRACTION. F. Anselin (Centre d'Études Nucléaires, Paris). p.108-11 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

X-ray examinations of massive samples of Pu were made by means of monochromatic x rays and a Seeman-Bohlin camera with asymmetric focusing. The pattern of α Pu obtained is shown. Indices of the first lines and their interplanar spacings are tabulated. (A.G.W.)

16561 THE DILATOMETRY AND THERMAL ANALYSIS OF PLUTONIUM METAL. E. M. Cramer, L. L. Hawes, W. N. Miner, and F. W. Schonfeld (Los Alamos Scientific Lab., N. Mex.). p.112-22 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Thermal expansion data on Pu metal from room temperature to the melting point as determined by a dilatometric method modified to take self heating into account are reported. A tubular specimen with a wall 0.017 in. thick was used to extend the measurements down to –180°C. Studies of the isothermal transformation behaviors within the temperature ranges of the known hysteresis gaps were made by holding the specimen at constant temperature for an extended time. By this method the hysteresis of the β/γ transformation was narrowed to 25°C and that of the γ/δ transformation to 3°C. A thermal analysis run gave results that agreed with the dilatometric runs. Two melting point determinations gave an average value of 639.5°C. (A.G.W.)

16562 A DILATOMETRIC STUDY OF PLUTONIUM. R. Abramson (Centre d'Études Nucléaires, Paris). p.123-32 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Results of dilatometric measurements made on Pu previous to 1958 are summarized. The equipment and procedures employed for 14 tests of the dilatometry of Pu are described briefly, and results obtained for a single specimen are reported. The curves indicate clearly the existence of six phases. Transformation temperatures and expansion coefficients are tabulated and compared with values obtained by others. (A.G.W.)

16563 SOME PHYSICAL PROPERTIES OF PLUTONIUM METAL STUDIED AT HARWELL. J. A. Lee and P. G. Mardon (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.133-51 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Equipment and techniques used in handling Pu at Harwell are described. Experimental methods and results of studies of the following physical properties of Pu are reported: phase transformation temperatures, thermal expansion characteristics, electrical resistivity, x-ray diffraction patterns, specific heat, thermal conductivity, kinetics of the $\alpha \rightleftharpoons \beta$ transformation, and Young's modulus. In a search for the nuclear magnetic resonance of Pu^{239}, no resonance has yet been detected in the range 0.27 – 0.58 nuclear magneton. Unusual features among the physical properties of Pu and their possible explanations are discussed briefly. (A.G.W.)

16564 SOME PHYSICAL AND PHYSICOCHEMICAL PROPERTIES OF PLUTONIUM METAL. A. E. Kay (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). p.183-93 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Results of specific-heat measurements by an adiabatic method with the self heat as the constant heat source are reported. Measurements of Young's modulus were made at room temperature. Tensile measurements gave a value of 8.2×10^{11} dynes/cm^2; compression measurements gave a value of 9.9×10^{11} dynes/cm^2. A study of the behavior of Pu when exposed to atmospheric conditions at different temperatures indicated that moisture plays a significant part in determining the oxidation rate in air at ordinary temperatures. At higher temperatures the oxidation law is probably linear for the β and γ phases but parabolic for the δ and ϵ phases. The oxidation rate in the δ phase is lower than that observed in the γ phase. (A.G.W.)

16565 THE MICROGRAPHY OF PLUTONIUM. H. Monti (Centre d'Études Nucléaires, Paris). p.205-9 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Techniques for the preparation and examination of very small samples of Pu are described. Samples were mounted in Araldite, polished mechanically, then electrolytically in a bath of H_3PO_4 and diethylene glycol, and examined under polarized light. Samples examined as reduced or after annealing were characterized by a very fine and fragmented grain structure. By heating the sample in the β-phase temperature range and cooling it slowly, a larger grain size was obtained. Attempts to etch the samples were unsuccessful. (A.G.W.)

16566 PHASE DIAGRAMS OF PLUTONIUM ALLOYS STUDIED AT HARWELL. M. B. Waldron (Atomic Energy

Research Establishment, Harwell, Berks, Eng.). p.225-39 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Thermal analysis, dilatometry, metallography, and x-ray crystallography were used to study Pu-alloy systems. Phase diagrams of the Pu–Fe, Pu–Th, and Pu–U systems are shown. Information obtained to date on Pu alloys with Ti, Zr, and Hf is summarized. The alloying behavior of Pu in relation to the atomic radii and the valencies of the elements involved is discussed. (A.G.W.)

16567 PLUTONIUM PHASE DIAGRAMS PUBLISHED BY THE RUSSIANS. F. W. Schonfeld (Los Alamos Scientific Lab., N. Mex.). p.255-64 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Phase diagrams for the binary systems of Pu with Be, Fe, Pb, Mn, Ni, Os, V, Al, Bi, Cr, Cu, Mo, Th, U, and Zr are shown. Some comparisons are made between Soviet diagrams and those determined at Los Alamos and Harwell. (A.G.W.)

16568 THE PREPARATION OF PLUTONIUM–ALUMINUM AND OTHER PLUTONIUM ALLOYS. O. J. C. Runnalls (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.309-30 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Preparation of Pu–Al alloys by reduction of PuO_2, PuF_3, or PuF_4 with an excess of Al was studied. Reduction of PuF_3 was dependent on removal of gaseous aluminum fluorides from the reaction zone; Pu yields averaged 98%. Reduction of PuO_2 proceeded readily in the presence of cryolite at 1200°C; yields were consistently above 99%. Other alloys successfully prepared by reduction of PuF_3 by the metal include Ga, Be, and Si alloys. PuF_3 was not reduced by In or Tl. Pu–Be alloys were also prepared by reduction of PuO_2. Results of preliminary experiments on preparation of Pu alloys of Th, U, and Mg by the direct reduction of PuF_3 or PuF_4 are reported. (A.G.W.)

16569 THE ROLE OF PLUTONIUM IN NUCLEAR POWER. R. M. Kiehn (Los Alamos Scientific Lab., N. Mex.). p.333-9 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961. (LADC-3123)

In spite of the fact that the nuclear properties of Pu are attractive from a fission reactor standpoint, Pu reactor technology has advanced slowly for two reasons: (1) Pu has not been generally available in large quantities, and (2) Pu presents an extreme health hazard. Recent increased interest in Pu reactor fuels is based on the argument that the estimated U^{235} reserves will not appreciably extend the energy resources of the world beyond the limit of fossil fuels and the expectation that Pu supplies will gradually be built up as U-fueled reactors are brought into operation. The fuel reactivity contribution, the fuel burning efficiency, and the fuel breeding ratio capability of Pu^{239} and U^{233} are shown for thermal, 100-kev, and 1-Mev neutrons. The properties that Pu fuels must possess and some possibilities for development of the fuels are discussed. (A.G.W.)

16570 THE PREPARATION OF PLUTONIUM–ALUMINUM ALLOY FUEL ELEMENTS FOR THE NRX REACTOR. K. L. Wauchope (Atomic Energy of Canada Ltd., Chalk River, Ont.). p.340-6 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Pu–Al alloy prepared by Al reduction of PuO_2 in the presence of cryolite is cast in graphite molds. The cast slugs are machined to a diameter of 1.360 in. and inserted into finned Al sheaths, which are drawn down into close contact with the alloy slugs. The ends are sealed by welding to Al outer fittings. Leak tests are made. The alloy preparation, casting, and machining steps are carried out in glove boxes. Subsequent operations can be carried out in fume hoods or open shops. (A.G.W.)

16571 THE DEVELOPMENT OF PLUTONIUM-CONTAINING FUELS AT THE ARGONNE NATIONAL LABORATORY. L. R. Kelman and R. J. Dunworth (Argonne National Lab., Ill.). p.365-82 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Advantages and problems associated with use of Pu as a fast-reactor fuel and general fuel-alloy requirements are summarized. Alloys of U, Pu, and fissium (mixture of metallic elements found in fission products) were studied for possible use as EBR-II fuel elements. The alloys studied showed practically no irradiation damage at moderate irradiation temperatures but swelled badly at elevated temperatures. In general, the studies indicated that alloying to stabilize the γ structure of U was effective in improving irradiation stability. The alloys also possess excellent thermal cycling stability; they can be remotely injection-cast into long, small-diameter pins; they resist attack by the liquid Na thermal bond and are compatible with the reprocessing cell environment; and they have reasonable thermal expansion characteristics. They are relatively poor thermal conductors. (A.G.W.)

16572 PLUTONIUM FUELS FOR POWER REACTORS. S. F. Pugh (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.383-93 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

Recycling of Pu in combination with natural U as the fuel in thermal reactors could be accomplished either by uniformly distributing the Pu throughout the reactor core in identical fuel elements containing both U and Pu in a single alloy or by introducing a number of Pu alloy "spike" elements distributed among the natural U elements. The advantages and disadvantages of these alternative procedures and the type and composition of Pu alloy required for each are discussed. Results of irradiation tests of Pu-containing alloys of the following types are reported: (1) those based on U, (2) those based on U plus 28 at % Mo, (3) Th-based alloys, and (4) a Zr–Pu alloy. (A.G.W.)

16573 THE HANFORD PLUTONIUM-RECYCLE TEST-REACTOR DESIGN CONCEPT. R. M. Fryar (General Electric Co., Richland, Wash.). p.394-402 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

The purpose and design of the Plutonium Recycle Test Reactor (PRTR) are described. The PRTR is a vertical-pressure-tube type of reactor, is heavy-water moderated and cooled, and has a thermal power rating of 70 Mw. It is characterized by a high degree of flexibility, low neutron temperature, independent accessibility of the fuel elements, and comprehensive instrumentation for experimental purposes. (A.G.W.)

16574 A PLUTONIUM LIQUID-METAL-FUEL REACTOR. David H. Gurinsky (Brookhaven National Lab., Upton, N. Y.). p.403-9 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

A schematic diagram of a liquid-metal-fuel reactor being studied at BNL is shown. The fuel is circulated through the moderator or core of the reactor and then to the heat exchanger. The fuel currently under investigation is a solution of U in Bi. The possibilities of using a Pu fuel system in the reactor and the metallurgical research and development program required are discussed. Data on the solubilities of U and Pu in Bi are included. (A.G.W.)

16575 A FLUID-FUELED FAST-POWER-REACTOR CONCEPT. Russell E. L. Stanford (Atomic Power Development Associates, Inc., Detroit). p.410-15 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

A "paste" reactor design concept involving the use of fissionable and fertile materials in the form of small spherical particles settled in a liquid metal carrier, presumably Na, is described. Diagrams and preliminary design calculations are included. (A.G.W.)

16576 A MIXED-OXIDE CONCEPT FOR A PLUTONIUM-FUELED POWER REACTOR. W. M. Cashin (General Electric Co., Schenectady, N. Y.). p.416-24 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961.

The mixed oxide concept for a fast-breeder reactor involves utilization of a mixture of Pu and U oxides as the fuel material. A 1 to 5 ratio of Pu to U, the U being either natural or depleted, is being considered. Studies of the performance of this type of fuel under the thermal and irradiation environment of a reactor indicate that the concept is feasible. Emphasis is being placed on economy in fuel preparation, irradiation, and reprocessing. (A.G.W.)

16577 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS AND FUEL ALLOYS THEREFOR. (to U. S. Atomic Energy Commission). British Patent 920,795. Mar. 13, 1963. Priority date, Apr. 25, 1960, United States.

A Pu alloy is described which is especially suitable for use in a tantalum carbide-coated tantalum fuel container. The alloy consists of 8 to 12 at. % Fe, ~2 at. % C, and balance Pu, and it tends to maintain the integrity of the tantalum carbide coating by forming carbide in any cracks. Several methods for preparing the alloy are described briefly. (D.L.C.)

16578 IMPROVEMENTS IN OR RELATING TO THE PRODUCTION OF LOW PERMEABILITY CARBON. Herbert Lawrence Rivington (to General Electric Co.). British Patent 921,236. Mar. 20, 1963. Filed Aug. 28, 1959.

A method for producing low-permeability carbon comprises heating a monomeric cyclic carbon compound under pressure to effect polymerization, and heating the polymer further to effect carbonization. A suitable monomer is furfuryl alcohol, which may be converted into carbon in a pressure bomb by raising the N_2 pressure to 2000 psi, and the temperature slowly to 400°C over 3 days. After carbonization is completed, the resulting product is next heated to 1000°C at the rate of 300°C/hr to drive off any volatile matter. The resulting carbon has a permeability on the order of 10^{-7} Lusecs. (D.L.C.)

16579 IMPROVEMENTS IN OR RELATING TO APPARATUS FOR VACUUM MELTING AND CASTING METALS. John William Smurthwaite (to United Kingdom Atomic Energy Authority). British Patent 921,484. Mar. 20, 1963. Filed Sept. 21, 1959.

A vacuum apparatus is designed for the melting and casting of radioactive metals such as uranium. In its operation, the beta-active vapor from the crucible is condensed on a cooled plate. After operation, the crucible assembly is transferred to a protected area for cleaning. (D.L.C.)

16580 APPLYING TITANIUM-ALLOYS FOR MANUFACTURING PARTS WHICH REMAIN DUCTILE AFTER WELDING. R. I. Jaffee, H. R. Ogden, and R. A. Happe (to Crucible Steel International, S. A.). German Patent DAS 1,142,445. Jan. 17, 1963. Filed Feb. 26, 1953.

It was discovered that certain kinds of alloys based on titanium remain ductile after welding. These alloys are composed of at least 70% Ti, 0.25–7.5% Al, and/or 0.25–16% Sn and in addition one or more of the subsequently cited elements observing the specified doses: 0.25 to 5% Bi or In, 0.1 to 10% Nb, Ta, or Zr, 0.1 to 30% V, 0.1 to 15% W, 0.1 to less than 2% Fe or Co, 0.1 to 1.5% Ni, 0.1 to 2.5% or 4 to 5% or 7.5% Mn, 0.1 to 2.5% or more than 5% up to 12.5%, eventually up to 18% Cr, 0.1 up to 2.5% or 5 to 15%, eventually up to 20% Mo, and also up to 0.3% O, up to 0.3% C, and up to 0.2% N. (Gmelin Institute)

16581 ELECTRON PROCESSING OF SEMICONDUCTING MATERIAL. Bernard A. Kulp and Raymond H. Kelley (to U. S. Navy). U. S. Patent 3,082,162. Mar. 19, 1963. Filed Oct. 24, 1960.

A process is given for producing semiconducting material with controlled amounts of interstitial atoms and vacancies in the space lattice. The process, based on electron-induced diffusion, comprises bombarding with electrons a semiconducting material coated with a layer of interstitial atoms in order to drive the atoms into the lattice. The process is described with reference to CdS crystals. (D.L.C.)

Corrosion

16582 (ARF-B198-36) IMPROVED ZIRCONIUM ALLOYS. Quarterly Report, October 1, 1962–December 31, 1962. D. Weinstein and F. C. Holtz (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Jan. 10, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(11-1)-578. 10p. (EURAEC-554)

A number of ternary compositions were developed for service in 680°F water which meet the objectives of a zirconium alloy improvement program on the basis of corrosion resistance, strength, and hydrogen pickup. These are compositions based on Zr–1Sb, Zr–1Cr, Zr–0.5Nb, and Zr–0.5Sn with minor additions of Te, Ge, Cr, or Fe. In 750°F steam, the materials Zr–3Cr–1Fe, Zr–3Cr–0.25Te, and Zr–1V–1Fe are initially acceptable on the basis of corrosion resistance and strength; however, hydrogen pickup is excessive. The current work is for the study of ternary alloys which are intended to show an optimum combination of corrosion, strength, and hydrogen-pickup properties. (auth)

16583 (EURAEC-545) IMPERFECTIONS IN METALS. II. CORROSION AND OXIDATION. Quarterly Report No. 1, October 1–December 31, 1962. (Mol, Belgium. Centre d'Étude de l'Énergie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 082-62-7 RDB. 11p. (R-2199)

An explanation of the solid state viewpoint on oxidation and corrosion of metals is presented. An electron microscopic study of the oxidation process is discussed since this technique allows for study of dislocations and their movement through the crystal lattice and since indications are that a correlation exists between oxidation sites and dislocations. A survey on preparation techniques of thin metal foils suitable for electron microscopical research is given and some preliminary results on annealed and quenched pure niobium are presented. (H.G.G.)

16584 (EURAEC-550) IN-PILE CORROSION OF NUCLEAR MATERIALS. Quarterly Report No. 3, October 1–December 31, 1962. (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 084-62-3 RDB. 16p. (R-2202)

Progress on in-pile and out-of-pile experiments concerning corrosion of nuclear materials is reported. Progress was made in the construction and testing of different parts of the new in-pile system. The design of the unreloadable loop system was revised as a result of experiments with high pH solution. In pile experiments were performed on the effect of coupling Al to stainless steel in passivating solutions and on the solution effects on platinum electrodes. A study on the mechanism of the oxidation of pure Al was completed. An apparatus was developed which permits simultaneous microscopic observations, photographic recording, and transitometric measurements. Capsule irradiations of Zr were made and specimens investigated with the Coulostatic single pulse method after irradiation. (H.G.G.)

16585 (EURAEC-569) MICROGRAVIMETRIC INVESTIGATION INTO THE MECHANISMS OF CORROSION OF REACTOR MATERIALS IN THE PRESENCE OF NUCLEAR RADIATION. Quarterly Report No. 4, October 1 to December 31, 1962. (Battelle Institut e. V., Frankfurt am Main). Work Performed under United States–Euratom Joint Research and Development Program. Contract 071-61-12-RDD. 27p.

Foils made of 99.999% Fe (6 μ thick) and of Armco Fe (10 μ thick), annealed in hydrogen at 800°C for 6 hours, were exposed to corroding atmospheres (O_2 and H_2O) for 5 to 7 hr at 25 and 250°C. No weight gain was observed in the experiments at 25°C, but at 250°C, weight gains of several hundred $\mu g/cm^2$ day were observed. Corrosion proceeded faster with the 99.999% Fe foils than with Armco Fe foils. The slopes of the log weight gain–log time curves recorded at 250°C agree ~ with equation $\Delta g = A \cdot t^n$, where Δg = weight gain in $\mu g/cm^2$, A = constant, t = time in min, and exponent n ~0.3. (auth)

16586 (GEAP-4098) EVALUATION OF ZIRCONIUM 1.5 W/O NIOBIUM CLADDING FOR USE IN BOILING WATER REACTOR ENVIRONMENTS. W. C. Rous and C. J. Baroch (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Oct. 1962. Contract AT(04-3)-189. 24p.

Research has indicated that a Zr–1.5 wt % Nb alloy has a corrosion rate in 680°F water and 750 and 900°F steam about the same as Zircaloy-2, and a hydrogen pickup rate about $\frac{1}{4}$ that of Zircaloy-2. It was also reported that the hydride in the Zr–Nb alloy apparently precipitated as spherically shaped particles rather than thin plates. Based on the favorable results of these corrosion tests an AEC Fuel Cycle Special Assembly 6L was designed to test the irradiation performance of Zr–1.5 wt % Nb as fuel rod cladding. Sixty-six feet of Zr–1.5 wt % Nb tubing was obtained to fabricate assembly 6L. Concurrent with the fabrication of the 6L assembly, samples of the tubing were corrosion tested with a surface heat flux of 205,000 BTU/hr-ft^2. Under these conditions, the corrosion rate of the Zr–Nb tubing was found to be 6 to 10 times that of Zircaloy-2. The as-received Zr–1.5 wt % Nb tubing was annealed at a temperature which favored the formation of an alpha plus beta structure. It was demonstrated that the alpha stabilized structure is far more corrosion resistant than the alpha plus beta structure. Therefore, a sample of the tubing was annealed to stabilize the alpha structure and the BWR corrosion test repeated. The corrosion rate of the alpha stabilized Zr–1.5 wt % Nb tubing was still 6 to 10 times that of Zircaloy-2. Consequently, the Zr–1.5 wt % Nb tubing was replaced by Zircaloy-4 as the clad material for the 6L assembly. Research conducted since June 1961 has indicated that the corrosion resistance of the Zr–Nb alloys is quite sensitive to the nitrogen content in a BWR environment, but in 750°F and higher temperature steam, the corrosion rate is relatively insensitive to the nitrogen content of the alloy. The poor corrosion resistance of the Zr–1.5 wt % Nb tubing was probably caused by high nitrogen content, 170 ppm, which had not affected the alloy performance in steam corrosion tests. (auth)

16587 (GEAP-4165) GENERAL AND STRESS CORROSION OF HIGH NICKEL ALLOYS IN SIMULATED SUPERHEAT REACTOR ENVIRONMENT. W. L. Pearl and G. G. Gaul (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 1963. Contract AT (04-3)-189. 47p.

The results of a program to evaluate the corrosion-resistance properties of high nickel alloys in simulated super-heat facilities are presented. Inconel, Incoloy, and Hastelloy-X have excellent corrosion resistance in comparison to previously tested type 304 stainless steel. The Incoloy heat transfer sheaths indicated a higher corrosion than Inconel in 1000 hours, but the Incoloy appears to lose only ~$\frac{1}{5}$ of its corrosion product to the system as compared to $\frac{1}{3}$ in the case of Inconel. The descaled weight loss data for the three high nickel alloys that were exposed isothermally to 1050°F superheated steam for 5200 hours indicate little corrosion occurring after the first 1000-hours exposure. (H.G.G.)

16588 (HW-75626) FRETTING CORROSION OF $\frac{1}{8}$-INCH Zr-2 [Zy-2] CLAD THERMOCOUPLES. Vincent F. FitzPatrick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Nov. 30, 1962. Contract AT(45-1)-1350. 7p.

A test to determine the susceptibility of Zr-2 clad thermocouples to fretting corrosion in dynamic systems is described. A dynamic test was performed in TF-7 under operating conditions of 300°C, 55 to 60 gpm flow, and velocity of 5.6 to 6.2 ft/sec over a period of 1014 hours. No fretting was observed during the test. The use of Zr-2 clad thermocouples embedded in the core of a prototypical fuel element for fouling detection of particulate solids which circulate through the reactor piping system is proposed. (H.G.G.)

16589 (NMI-1254) FUNDAMENTAL AND APPLIED RESEARCH AND DEVELOPMENT IN METALLURGY. RESEARCH ON THE MECHANISM OF ZIRCONIUM ALLOY CORROSION IN HIGH-TEMPERATURE STEAM. Summary Technical Report to United States Atomic Energy Commission for the Period July 1, 1961–June 30, 1962. (Nuclear Metals, Inc., West Concord, Mass.). Feb. 25, 1963. Contract AT(30-1)-2784. 71p.

Progress in research on the mechanism of zirconium alloy corrosion in high-temperature steam is reported in two parts: cracking of thick oxide films on zirconium alloys in high-temperature steam and modification of surface oxide films on zirconium. Separate abstracts were prepared for each part. (M.C.G.)

16590 (NMI-1254(p.3-43)) CRACKING OF THICK OXIDE FILMS ON ZIRCONIUM ALLOYS IN HIGH-TEMPERATURE STEAM. D. S. Kneppel and J. P. Pemsler (Nuclear Metals, Inc., West Concord, Mass.).

Investigations were made into the cracking of oxide films formed on zirconium alloys during high-temperature steam corrosion at atmospheric pressure. Replacement of the corroding medium with dry HCl resulted in reaction of the metal at the base of cracks, through the oxide film, which

occurred when the oxide thickened rather than as a result of thermal stresses during cooling. The oxide films were formed on zirconium alloys by exposure to high-temperature steam at atmospheric pressure. The maximum weight gains attained in any of the alloys before cracking was observed were 300 mg/dm^2 at 600°C and 400 mg/dm^2 at 700°C. Some alloy samples showed cracking of the oxide film through to the base metal with weight gains of only about 160 mg/dm^2. In general, the alloys which showed better corrosion resistance to the high-temperature steam also withstood cracking of the oxide films to higher weight gains. No correlation with the effect of heat treatment was found. The optimum heat treatment for each alloy for greatest resistance to cracking was different for each alloy. Zircaloy-2 corroded to a weight gain of about 50 mg/dm^2 in either steam or oxygen at 427°C (800°F) and one atmosphere showed no indication of oxide film cracking at temperature. Similarly, unalloyed zirconium that was corroded to a weight gain of 50 mg/dm^2 in steam also showed no crack formation that could be detected by decoration with dry HCl. (auth)

16591 NMI-1254(p.44-65)) MODIFICATION OF SURFACE OXIDE FILMS ON ZIRCONIUM. A. G. Tobin and J. P. Pemsler (Nuclear Metals, Inc., West Concord, Mass.).

Investigations were carried out on means of altering the composition of the oxide formed on unalloyed zirconium, and to study the effect of modifications on its high-temperature oxidation properties. Attempts were made to introduce foreign metallic ions into the zirconium oxide lattice by the replacement reaction at 500°C: $2MeCl_2$ (g) + $ZrO_2 \rightarrow 2MeO$ (s) + $ZrCl_4$ (g). The chlorides of Ta, Nb, Ti, Si, and Al were used because of their volatility and thermodynamic probability of reaction with ZrO_2. Exposure of these gaseous chlorides to thin oxide films on zirconium resulted in heavy reaction at selected sites only. No improvement in oxidation resistance was effected. Direct vacuum depositions of thin metallic films (Ni, Cr, Al, Zn, Sn, and Cu) on zirconium or pre-oxidized zirconium substrates, followed by a homogenizing diffusion heat treatment, was also tried as a means of altering the surface layers of unalloyed zirconium. Examination of the oxide formed after exposure of the treated zirconium to high-temperature oxygen showed no alterations in the type of oxide film as compared to that formed on zirconium with no foreign metallic film. The treatment resulted in no additional oxidation resistance except that inherent in the deposited metal. (auth)

16592 (TID-17940) VISIT TO SOVIET CORROSION CHEMISTRY INSTITUTES, JUNE 25–JULY 4, 1962. J. E. Draley (Argonne National Lab., Ill.) and F. W. Young, Jr. (Oak Ridge National Lab., Tenn.). Contracts [W-7405-eng-26 and W-31-109-eng-38]. 24p.

A visit to the U.S.S.R. for the purpose of observing fundamental corrosion research in the Soviet Union is described. Three corrosion chemistry research institutes were visited and two leading Soviet research chemists were interviewed. Eighty-three reprints of Soviet papers concerning corrosion problems and research were obtained and are listed. (H.G.G.)

16593 (VDIT-5a) THE CORROSION OF STAINLESS STEEL. A Bibliography of Selected Literature. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). [1959]. 19p.

This bibliography contains selected abstracts of publications concerning the stress corrosion of stainless steel, austenitic and other, and the corrosion of stainless steel in general. Only five references were found that treat the failure of technical equipment (e.g., heat exchangers) due to stress corrosion. The remaining references refer to laboratory experiments. The last part of the bibliography consists of fifteen references on the welding of tubes to tube sheets in heat exchangers. The selected literature includes publications from 1948 to 1959. (auth)

16594 (EURAEC-29) CORROSION PROBLEMS. Quarterly Report No. 1, March 1–May 31, 1960. (Brussels. Centre Belge d'Étude de la Corrosion; Brussels. Centre d'Étude de l'Énergie Nucléaire; and Brussels. Société d'Études, de Recherches et d'Applications pour l'Industrie). June 1960. Work Performed under United States–Euratom Joint Research and Development Program. 48p. A translation.

The progress attained in the study of corrosion problems affecting Ni and stainless steel is described. The essential purpose of the research work is to determine the relevance and practical interest of the electrochemical methods applied to corrosion studies based on the plotting and interpretation of polarization curves in stirred solutions. Stainless steel in sulfuric acid and in sodium bicarbonate solutions was studied. A study was also made concerning the behavior of pure aluminum in ammonium nitrate and ammonium phosphate solutions by means of the chronopotentiometric method. (H.G.G.)

16595 (EURAEC-552) STUDIES OF STEEL CORROSION IN HIGH TEMPERATURE WATER AND STEAM. Quarterly Report No. 2, October 1 to December 31, 1962. (Brussels. Société d'Études, de Recherches et d'Applications pour l'Industrie). Jan. 30, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 089-62-7RDB. 141p. A translation.

Experiments to determine the influence of the surface state on steel corrosion in high temperature steam and water are discussed. Static tests in autoclaves to determine corrosion of stainless steel type 304 for residence times of 2 and 6 weeks in water at 300°C and a residence time of 6 weeks in steam at 400°C and 200 kg/cm^2 were conducted. These results showed a marked influence of the surface state on the behavior of stainless steel in water at 300°C for both residence periods. The samples polished in the JACQUET were by far the best, the milled and ground conditions were equivalent, and the emery 600 mechanically polished state was less good. In steam at 400°C and 200 kg/cm^2, the influence of the surface state was insignificant for a residence of 2 weeks. (H.G.G.)

16596 (EURAEC-559) RESEARCH ON SOME PROBLEMS RELATING TO METAL OXIDATION AND APPLICATION OF IMPEDANCE MEASUREMENT METHODS TO AN INVESTIGATION OF CORROSION RESISTANCE IN AN AQUEOUS ENVIRONMENT. Quarterly Report No. 3, October 1 through December 31, 1962. (Brussels. Universite). Work Performed under United States–Euratom Joint Research and Development Program. Contract 081-62-5RDB. 7p. A translation.

Research on problems relating to oxidation of Cu–O, Cd–O, and Ni–O systems is discussed. The existence of a nucleation-germination phenomenon is exhibited in a study of these systems. Research on selective oxidation in the field of stability of nickel oxide of alloys with a non-homogenous nickel distribution shows that the germ density is little affected by the nickel concentration. The first experiments of silver iodization at ambient temperature and at iodine pressure of 10^{-1} mm made it possible to dem-

onstrate the presence of a nucleation-germination phenomenon. (H.G.G.)

16597 STUDY OF THE RESISTANCE TO CORROSION IN ACID MEDIUM OF A CONSTRUCTION STEEL. Orlando Euler de Castro (Institut de Recherches de la Siderurgie Francaise, Saint-Germain-en-Laye, France). Compt. Rend., 256: 159-61(Jan. 2, 1963). (In French)

During a study on welded assemblies, the corrosion resistance of a steel with 0.22% C, 1.05% Cr, and 0.25% Mo, submitted to varied thermal treatments, was studied. The different microstructures obtained lead to different weight losses. The evolution of the dissolution potential during the attack was followed. (tr-auth)

16598 CORROSION IN THE NUCLEAR POWER INDUSTRY. Corrosion Technol., 9: 68-70(Mar. 1962).

A review is given on the corrosion of reactor alloys, covering corrosion and hydrogen absorption of Zircaloy subjected to steam at high temperatures and pressures; corrosion of Inconel and Nb alloys in pressurized water reactors; oxidation of Be in CO_2 at high temperatures; galvanic corrosion of fuel cans during underwater storage; and high temperature oxidation and ignition of Mg can alloys. (P.C.H.)

16599 CORROSION OF IRON IN OXYGEN-CONTAINING CONDENSATE. G. Resch and H. Odenthal. Korrosion, 15: 33-40(1962). (In German)

A series of studies were made at 20°C on the oxygen corrosion of steel sheets and tubes with the composition C ≤ 0.22%, Si ≤ 0.35%, Mn > 0.45%, and P and S each 0.05%. The basic effects of the streaming velocity of the medium, the type and concentration of various anions, and the hydrogen ion concentration on the corrosion were determined for the shortest research time possible. The effects of sodium chloride and sodium sulfate were also investigated. The results are shown in graphic and micrographic form. (J.S.R.)

16600 THE EROSION CORROSION OF IRON IN NEUTRAL AND WEAKLY ALKALINE WATERS. H. E. Hoemig. Korrosion, 15: 41-5(1962). (In German)

Some ideas on the mechanism of the erosion corrosion of iron in neutral and weakly alkaline solution are discussed approximately. The stability of iron in pure water, transport processes at the boundary layer, and the effect of dissolved oxygen are considered. (J.S.R.)

16601 NEW ADVANCES ON THE REACTION BETWEEN STEEL AND WATER AT HIGH TEMPERATURES. E. C. Potter (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). Korrosion, 15: 51-4(1962). (In German)

The latest results on the mechanism of the formation of magnetite formed at high temperatures in the presence of water are briefly reviewed. Then the oxidation process on the boiler surface exposed to water is summarized. (J.S.R.)

Fabrication

Refer also to abstracts 17438, 17443, 17447, and 17448.

16602 (ANL-6276) FABRICATION OF EBR-II, CORE I FUEL ELEMENTS. N. J. Carson, N. R. Grant, N. F. Hessler, H. F. Jelinek, R. H. Olp, and A. B. Shuck (Argonne National Lab., Ill.). Dec. 1962. Contract W-31-109-eng-38. 37p.

Activities in a program to assemble and test jacketed fuel rods and multi-rod fuel rod assemblies for EBR-II are reported. Other work is reported on evaluation of the manufacuring techniques proposed for the EBR-II cycle in a sustained operation and on remotely operable equipment under production conditions. Data on fabrication and assembly of fuel rods and assemblies are included. A total of 10,781 fully inspected fuel rods were fabricated for EBR-II core by processes adaptable to remote operation. (J.R.D.)

16603 (ANL-FGF-409) NEW FABRICATION PROCEDURES FOR HIGH-QUALITY TUBING. N. H. Polakowski and J. E. Flinn, Jr. (Argonne National Lab., Ill.). Jan. 2, 1963. Contract [W-31-109-eng-38]. 18p. (UAC-7165)

Small tubing used in nuclear reactors and other critical applications must represent the ultimate insofar as structural integrity is concerned. Freedom from cracks and surface defects is particularly important. A satisfactory outside surface can be secured on drawn tubing with relative ease by suitable lubricating and anti-galling substances. The interior, however, if unsupported during some drawing passes, deteriorates when the ID is progressively reduced. Cracking on radial planes emanating from the inside surface may result after a large overall reduction. To eliminate or drastically reduce the sinking component, three methods of supporting the interior during drawing were tried successfully: (a) a ductile metal core, (b) mineral and organic powders, or (c) a ductile metal core with a powder barrier between core and tube. Examples of drawing Cu, 304 stainless steel, and Nb–10 wt % Ti–5 wt % Zr tubing are described. Problems associated with wall thickness control and core removal are discussed from the standpoint of tube drawing theory. The potential suitability of these methods for warm processing of refractory metals (Mo, W) is indicated. (auth)

16604 (BRB-69) DYNAPAK EXTRUSION OF I & E FUEL ELEMENTS. PHASE II. TECHNICAL ACTIVITY ALPHA PHASE. Q. C. Carloni and L. Lewis (Bridgeport Brass Co., Conn.). Sept. 14, 1962. Contract AT(30-1)-1405. 39p.

A series of extrusion experiments were conducted to study the behavior of natural uranium I&E fuel elements under the influence of DYNAPAK extrusion. Results confirm that these elements can be successfully extruded. Metallographic examination reveals that included die entrance angles lower than 120 degrees favor the extrusion of tubes with a negligible amount of banding and improved quality. No one die or mandrel material was determined wholly satisfactory for high energy rate extrusion purposes during these tests. Complementary activity helped establish a ½-inch die extension as most compatible with the tooling setup, and ½- to ¾-inch thick carbon follower block requirement to fully empty the liner depending upon die entrance angle and extrusion temperature. Lengths of only 8 inches were extruded, but in no way represented the maximum potential of the unit. Dimensional control of these elements continues to be satisfactory, particularly on the inner diameter. Surface quality was also maintained at a high level indicating a need for little or no machining touch up. (auth)

16605 (CEND-173) BURNABLE POISON ADDITIONS TO UO_2. Progress Report, December 31, 1962. G. Zuromsky and W. P. Chernock (Combustion Engineering, Inc., Windsor, Conn.). Jan. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(30-1)-3107. 23p. (EURAEC-575)

Electromechanical and pneumatic compaction methods were utilized in conjunction with various powder loading techniques to produce high density UO_2 fuel elements containing 0.05 wt % B_4C additions. Densities of 87 to 88% of theoretical were attained in 10 to 20 min with the electromechanical approach and densities of 88 to 89% of theoretical were achieved in 3 to 5 min with the pneumatic unit. Local B concentrations determined by the sodium carbonate-quinalizarin colorimetric method were correlated with local variations in the quantities of fines. This correlation may become useful as a rapid method for evaluating B distribution. An analysis of self-shielding factors indicates that the −325 mesh B_4C particles selected for initial use in this program represents a truly "non self-shielded" particle size which is then amenable to the production of a homogeneous burnable poison distribution. Modifications to the existing thermal gradient test apparatus are being initiated to provide axial as well as radial thermal gradients for B redistribution measurements. (auth)

16606 (JEN-81-DMe/I6) DETERMINACION DE ACTIVIDADES SUPERFICIALES DE POLVOS CON EL APARATO BET. (Determination of Superficial Activities of Powders with BET Apparatus). E. Aparicio Arroyo and F. Carrasco Gimeno (Spain. Junta de Energia Nuclear, Madrid). 1960. 13p.

Due to the considerable influence exerted by the active surface of UO_2 particles on the sintering of powder of this material, the predetermining and checking of this magnitude in the production of this raw material becomes imperative. A critical study of existing methods is made in order to establish the most effective method for determining these superficial activities. A further study of the BET method for determination of superficial activities and its limitations is proposed. (auth)

16607 (NMI-4950) RIBBED BERYLLIUM TUBING EXTRUSION PROGRAM. PHASE I. Final Report. V. Nerses and J. M. Siergiej (Nuclear Metals, Inc., Concord, Mass.). May 17, 1961. For General Nuclear Engineering Corp., Dunedin, Fla. Contract [AT(30-1)-1565], Subcontract 40-7-11. 82p.

Three basic methods were employed to determine the feasibility of producing twisted rib Be tubing. These methods were: Filled Billet Method, whereby the cross section of the beryllium extrusion billet has the same relative shape as the cross section of the extruded product desired; Shaped Tooling, where the contour of the beryllium rib is formed during the extrusion process, and the inside diameter is controlled by use of a mandrel; and Modified Filled Billet, whereby the ribs are formed as in method 1, but the ID is contoured by use of a mandrel. Twenty extrusions were made during the course of the program, producing lengths up to 13 feet. All three methods proved to be practical and each could be employed in a production process; however, the shaped die process is recommended in preference to the filled billet method for both quality and economy considerations. Inspection of the tubing, especially that produced by the shaped die method, indicates that the tubes are basically sound and that they can be reproduced with a remarkable degree of consistency. The burst test data indicate that the hoop stresses approach 100,000 psi on tubes processed in accordance with optimum procedures. Inspections by Dy-chek penetrant techniques and the helium leak detectors did not reveal any abnormalities as a result of the fabrication methods used. The required helical twist at first was scheduled into the tube as a post-extrusion operation, the tube being twisted while at an elevated temperature. It was found possible, however, to design a shaped die so that the twist could be produced during the actual extrusion, and this method now appears to offer many advantages. (auth)

16608 (NP-12615) THE INVESTIGATION OF EXOTHERMIC BRAZING OF REFRACTORY ALLOYS. Quarterly Report No. 1, November 1, 1962–January 31, 1963. R. O. Banning, J. R. Armstrong, and R. A. Long (Narmco Research and Development. Div. of Telecomputing Corp., San Diego, Calif.). Feb. 28, 1963. Contract N600(19)-59237. 23p.

Heat-producing and heat and metal-producing exothermic systems for brazing of refractory alloys were evaluated. Characteristics taken into consideration were: heat of reaction, ignition temperature, metal production, metal-ceramic composite characteristics, and base metal-exotherm compatibility. Brazed joints were made in unalloyed molybdenum, tungsten, niobium, and tantalum, using commercially-available brazing alloys with flow temperatures ranging up to 3100°F. Brazing was accomplished in air without protective atmospheres with essentially no oxidation or contamination of the base metals. (auth)

16609 (NYO-10214) DEVELOPMENT OF UNIQUE METHODS FOR RADIOACTIVE SOURCE FABRICATION—VIBRATORY COMPACTION. Quarterly Progress Report I. (General Scientific Corp., Washington, D. C.). July 1962. Contract AT(30-1)-2981. 36p.

Efforts during the quarter were devoted primarily to the design of the compaction mechanism, the procurement of commercial equipment and materials, and the initiation of design fabrication. A chuck-design vibratory compaction mechanism was selected for use in source fabrication. Various designs were considered for transporting the powders from ground level to the top of the rod. These methods include enclosed blowers, screw lifts and belts, and pulley mechanisms. It appears that the remote manipulators can be utilized to handle this task if the hot cell to be utilized permits sufficient overhead movement. A cannister will be utilized for transferring the power from a classifying machine to the rod filling mechanism. It will have a spring loaded bell valve which will be opened automatically when seated in the rod filling mechanism and which will close automatically when removed. The rod filling mechanism, in addition to housing the cannister, will have a weighted plunger which will create a static load on the powder in the rod during vibration. Analyses are being made to determine parameters of a device for cooling the rod. The vibratory table and eight vibrators were received for free use in preliminary tests. The table and the most suitable vibrator will be purchased after the preliminary tests are complete. The cerium oxide powder was received and the strontium titanite powder is on order. A shaker for classifying the powders into practicle sizes is on order. Preliminary testing is planned in the latter part of July 1962. A diagram of the test apparatus is included. (auth)

16610 (EURAEC-522) FORMATION OF SWAGED UO_2 FUEL ELEMENTS. Final Report, April 1, 1960–June 30, 1961. (Nuklear-Chemie und -Metallurgie G.m.b.H., Wolfgang bei Hanau am Main, Germany). Work Performed under United States–Euratom Joint Research and Development Program. Contract 011-60-5 RDA. 21p. A translation.

Uranium dioxide powders were tested for their swaging properties. The powders used in the test were divided into

4 groups: powders obtained by smelting and grinding, powders prepared from ammonium diuranate, powders prepared by special precipitation methods, and powders that underwent an after treatment by soaking with a solution of uranyl nitrate and subsequent calcination. During processing, the powders were first precompacted in tubes of various sizes. Following this the pipes were flooded with argon and closed with welded plugs. A two-jaw swaging machine was used for further processing. To obtain the highest possible density, it was found best to first reduce the sections of the tubes by 20 to 30% by cold swaging and then to reduce them by a further 20 to 30% by swaging at 750°C. Better results were obtained with powders prepared by special precipitation methods and smelting and grinding than with the other two methods. (auth)

16611 (EURAEC-551) METHODS EMPLOYED IN THE FABRICATION OF PRESSURE VESSELS. Quarterly Report No. 4, October 1–December 31, 1962. (Neratoom, N. V., The Hague). Jan. 26, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 069-61-12 RD N. 18p. A translation.

The mechanical properties of two test plates of 200 and 300 mm thicknesses were tested and found satisfactory. A change in the time table for research on these two plates was necessitated. The program for the 300 mm thick plates will be completed in ~ 6 months, but $1\frac{1}{2}$ years will be required to complete research on the 200 mm thick plates. Good progress was made with preliminary research into arc-welding with CO_2 shielding. Application of a welding-wire grade with Al addition yielded no better results. Enclosed CO_2 welding was subjected to closer examination. Submerged-arc welding was successfully used in welding the first seam with the use of a single electrode. (H.G.G.)

16612 HIGH PURITY BeO FOR ELECTRONICS. R. J. Brown. Ceram. Age, 78: 51-6(Feb. 1962).

BeO ranging from 85 to 99% purity is wet-blended for dry-pressing, isopressing, and extrusion. It is air-fired in a dielectric oven. The characteristics of high purity BeO ceramics include thermal conductivity, dielectric properties, strength, and ease of metallizing. (P.C.H.)

16613 GRINDING ZIRCONIUM. Grinding & Finishing, 8: 40-1(Apr. 1962).

Wheel and belt recommendations, coolant requirements, and operational techniques for the surface, cylindrical, snagging, and cutoff grinding of Zr using SiC and AlO abrasives are presented. (Rev. Metal Lit., 19: No. 6, 1962)

16614 METALLURGISTS REPORT PROGRESS IN FORMING BERYLLIUM. Iron Age Metalworking Intern., 1: 32-4(Feb. 1962).

A review is given on the formation of Be components by either pressing encapsulated powders or forging hot pressed metal, including canned powder, canned block, bare block, hot pressing, and extrusion methods. Determinations were made of average density, tensile and yield strengths, elongation, and contraction. Discussion is also given on uses for aerospace heat shields, gyroscope parts, moderators, and reflectors. (P.C.H.)

16615 QUALITY OF ZIRCONIUM PREPARED BY DIFFERENT REDUCTANTS. G. W. Elger. U. S. Bur. Mines, Rept. Invest., 5933, 20p.(1962).

Zr metal was prepared by batch reduction of zirconium tetrachloride by Na, Mg, and Na–Mg mixtures. Chemical analysis and hardness testing of Zr arc-melted from sponge was made. (Rev. Metal Lit., 19: No. 5, 1962)

16616 REACTORS NEED SUPERLATIVE WELDING. Robert N. Williams. Welding Design Fabric., 35: 31-3 (May 1962).

Discussion is given on Tig, Mig, stick, and electron beam welding of atomic reactors using austenitic and ferritic stainless steel, stainless clad steel, Inconel, carbon steel, Zr, the precipitation hardening steels, and others. Testing by x ray, dye penetration, and magnetic particles is also included. (P.C.H.)

16617 IMPROVEMENTS IN CARBON PRODUCTS AND IN THEIR PRODUCTION. (to E. I. du Pont de Nemours and Co.). British Patent 918,880. Feb. 20, 1963. Priority date Dec. 23, 1959, United States.

Graphite having a density of at least 1.9 grams per cubic centimeter and a relative crystallite alignment of 70% or less were produced. A mass of graphite powder was surrounded with a detonating explosive that was uniformly distributed about the powder to obtain uniform compaction. For ease of handling and to prevent loss of material and powder the arrangement is encased in a container. This method lowers the porosity and increases the strength of the graphite. (C.E.S.)

16618 METALLURGICAL PROCESS FOR WORKING BERYLLIUM. Alan Moore and Charles Ian Bort (to United Kingdom Atomic Energy Authority). British Patent 919,423. Feb. 27, 1963. Filed date Oct. 4, 1960.

A method is provided for forming beryllium into shaped bodies having improved deformability and decreased tendency to anisotropy in mechanical properties. Beryllium is cast to form a coarse-grained ingot that is worked to form a shaped body with a fibrous grain structure that is then refined. (C.E.S.)

16619 METHODS FOR MAKING URANIUM CARBIDE ARTICLES. André Accary and Jacques Dubuisson (to Commissariat à l'Énergie Atomique). Canadian Patent 653,803. Dec. 11, 1962. Priority date Nov. 6, 1959, France.

Articles of higher value result from a new method of preparing UC articles. Uranium and graphite powders in stoichiometric proportions are mixed, and while in the mold have the specific gravity increased mechanically. Gradual heating of the mold to 1200°C in a vacuum completes the process. (D.C.W.)

16620 METHOD FOR THE MANUFACTURE OF THORIUM-CONTAINING GETTERS FOR ELECTRIC DISCHARGE TUBES. Egon O. M. Baronetsky and Johannes H. N. van Vucht (to N. V. Philips' Gloeilampenfabrieken). Canadian Patent 655,462. Jan. 8, 1963. Priority date Jan. 30, 1958, Netherlands.

A method of manufacturing a thorium-containing getter for an electric discharge tube is provided. Powdery thorium is mixed with pulverized aluminum and worked in a known manner into a getter. In order to provide a getter that has good activity for hydrogen and other gases even after absorption of a large amount of oxygen, the aluminum is partly substituted by one or more of the metals silver, gold, copper, and palladium. $Th_{16}Al_8Cu_3$ and $Th_{16}Al_8Au_3$ were found to have favorable properties. (C.E.S.)

16621 PREPARATION OF HIGH DENSITY SINTERED URANIUM DIOXIDE FOR NUCLEAR REACTORS. (to Associated Electrical Industries Ltd.). French Patent 1,264,209. May 8, 1961. Priority date July 15, 1959. Great Britain.

Uranium oxide, having the composition $UO_{2.1}$ to $UO_{2.25}$ is so pulverized that it acquires a surface of 2 m^2/g and mixed

with such a quantity of a $(NH_4)_2$ Pt Cl_6 sol. that the paste contains 0.1 wt % Pt. The paste is compacted, sintered in an inert atm. at 1400°C and finally heated at 1200°C in hydrogen. The final UO_2 compact has a density of 10.73 to 10.90 g/cm^3. (NPO)

16622 IMPROVEMENT IN THE PREPARATION OF REFRACTORY PRODUCTS, OBTAINED BY SOLID STATE REACTION, ESPECIALLY URANIUM NITRIDES. (to Commissariat à l'Énergie Atomique). French Patent 1,267,860. June 19, 1961. Filed June 13, 1960.

Uranium mononitride or uranium/uranium mononitride cermets are prepared by mixing uranium powder and a pulverized higher uranium nitride having a U/N ratio of 1.60 to 1.65, and sintering this mixture in a graphite sleeve at 800 to 1500°C under a mechanical pressure of 150 to 500 kg/cm^2. (NPO)

16623 METHOD FOR THE DIRECT PREPARATION OF GRANULAR MATERIAL CONTAINING URANIUM WITH A DETERMINATE PARTICLE SIZE AND A CLEARLY SPHERICAL SHAPE. (to Stichting Reactor Centrum Nederland). French Patent 1,271,794. Aug. 7, 1961. Priority date Sept. 18, 1959, Netherlands.

The patent relates to the preparation of granular fuel material, particularly UO_2, which can be applied in a reactor with a circulating aqueous fuel suspension (see French patent no. 1,105,731). Solid NH_4NO_3 is added to an uranyl salt solution and then so much aqueous NH_3 that no precipitate is produced. Precipitation is effected by the addition of solid $(NH_4)_2SO_4$, the pH being kept above a critical value between 2 and 3. The precipitate is preheated at 150°C, converted with aqueous NH_3 and finally reduced with H_2. The final product consists of spherical UO_2 particles, having a size of 4 to 7 microns. (NPO)

16624 METHOD OF PREPARING URANIUM CARBIDE AND APPLICATION OF THE PRODUCTS OBTAINED. (Deutsche Gold- und Silber-Scheideanstalt). French Patent 1,276,460. Oct. 9, 1961. Priority date Dec. 25, 1959, Germany.

Uranium monocarbide fuel compacts are prepared by submitting compacts of uranium oxide and graphite to the action of an electric arc at a temperature above 2450°C in a graphite furnace, the gas pressure in the furnace being kept constant and above 0.1 atm. (NPO)

16625 FUEL ELEMENT FOR NUCLEAR REACTORS AND ITS METHOD OF MANUFACTURE. (to Nukem Nuclear–Chemie und–Metallurgie). French Patent 1,283,560. Dec. 26, 1961. Priority date Nov. 4, 1960, Germany.

A metallic U slug is bonded to an Al jacket by means of a first layer of Ni (5 to 7 microns), an intermediate layer of Cr (4 to 6 microns), a second layer of Ni (3 to 5 microns) and a layer of Cu, the latter facing the Al. The bonding is effected at 600°C and 80 to 100 atm. (NPO)

16626 IMPROVEMENTS IN THE MANUFACTURE OF NUCLEAR FUEL ELEMENTS. (to Mitsubishi Atomic Power Industries, Inc.). French Patent 1,284,135. Jan. 2, 1962. Priority date Feb. 11, 1960, Japan.

In the manufacture of fuel elements by the swaging of powder-filled stainless steel tubes, the interior surface of the tubes is previously polished to remove a layer of at least 2 microns. (NPO)

16627 METHOD OF MANUFACTURE AND OPERATION OF FUEL ELEMENTS FOR NUCLEAR REACTOR. H. N. Schludi. French Patent 1,285,735. Jan. 15, 1962. Priority date Apr. 14, 1960, Germany.

The patent claims the application of external heat to fuel elements, e.g., by means of an electrical coil, during their manufacture, i.e., filling of cans with nuclear fuel, during their insertion in the reactor core and in the reactor when the latter is shut down or is operated at a lower power level in order to prevent irregular differences in dilatation between the fuel and the can. Thus the fuel can be charged and kept in the liquid or in the desired allotropic state, e.g., metallic U in the V phase. (NPO)

16628 THERMALLY RESISTANT ARTICLES AND METHOD FOR THEIR FABRICATION. James R. Johnson (to Minnesota Mining and Mfg. Co.). U. S. Patent 3,079,316. Feb. 26, 1963. Filed May 22, 1958.

A method is given for preparing a plastic mass for the production of intricate thin-walled siliconized silicon carbide articles and of graphite articles coated with silicon carbide, and for use as a welding agent between graphite joints. The plastic mass comprises a homogeneous mixture of 100 parts of finely divided carbon, 100 to 500 parts of finely divided silicon carbide, and 5 to 50 parts of a film-forming polymeric binder. In use, the plastic mass is formed into sheets and then shaped into the desired form, or it is spread in a film over an article to be coated, and then the form or coated article is heated to 3000 to 4000°F in the presence of excess silicon to eliminate the binder and to convert the mass into siliconized silicon carbide. (D.L.C.)

16629 METHOD OF MAKING TRANSISTORS. Preston Robinson (to Sprague Electric Co.). U. S. Patent 3,080,481. Mar. 5, 1963. Filed Apr. 17, 1959.

A process is given for making semiconductive devices. The process comprises projecting a focused electron beam on a semiconductor body in the presence of a polymerizable vapor to form a protective layer on the body, projecting the beam on a metal-containing body to volatilize the metal, condensing the metal vapor on the body, and subsequently removing the protective film and condensed metal from the body surface. An apparatus for carrying out the process is described. (D.L.C.)

16630 PROCESS OF MAKING A NUCLEAR FUEL ELEMENT. Osgood J. Whittemore, Jr. (to Norton Co.). U. S. Patent 3,081,249. Mar. 12, 1963. Filed May 21, 1957.

A process is outlined for making fuel elements which are resistant to structural damage from radiation, to corrosion, and to high temperatures and which will retain fission products. The method comprises providing finely divided refractory metal oxide of a fissionable material, adding an organic binder, forming the mixture into a core, surrounding the core with finely divided alumina, magnesia, zirconia, ceria, thoria, or mixtures thereof, compacting the sheath and core to produce a composite shape, and firing the composite shape. (D.L.C.)

16631 ELECTRON BEAM WELDING. William J. Greene (to Air Reduction Co., Inc.). U. S. Patent 3,082,316. Mar. 19, 1963. Filed Apr. 12, 1960.

An electron beam welding apparatus is designed with means for preventing gaseous discharges due to raising the pressure adjacent to the electrodes of the electron gun sufficiently to cause an arc. The means comprises separate chambers for the electron gun and the workpiece and a diaphragm therebetween for allowing passage of the electron beam while preventing transfer of gas particles from the workpiece chamber into the gun chamber. The diaphragm has an aperture of a diameter less than the mean free path of gaseous particles, and the electron beam is

converged to small diameter at the aperture in order to pass therethrough. (D.L.C.)

Properties and Structure

16632 (AD-274654) CARBONIZATION OF PLASTICS AND REFRACTORY MATERIALS RESEARCH. VOLUME II. REFRACTORY MATERIALS. Seventh Quarterly Progress Report, January 1, 1962–March 31, 1962. G. M. Kibler, T. F. Lyon, and V. J. DeSantis (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Mar. 31, 1962. Contract AF 33(616)-6841. 32p. (N62-11254)

Equilibrium nitrogen pressures over the ZrN single phase have been measured by determining the rate of nitrogen effusion from a Knudsen cell. The measurements span a range of temperatures from 1424 to 2360°K, a range of composition from 13.0 down to 9.79% nitrogen by weight and a range of nitrogen pressures from 2×10^{-8} to 3×10^{-5} atm. These data are presented graphically. In matrix isolation experiments, both infrared and visible spectra have been obtained from the matrix isolated species effusion from a Knudsen orifice in a cell containing ThO_2. The observed bands are tabulated, though the analysis of the spectra is not complete. Results of efforts to measure the resonance line absorption by B atoms over pure B have indicated serious interaction of the B with all container materials thus far investigated. The six compounds, NbB_2, TiB_2, ZrB_2, TaN, ZrN, and HfN, for which emissivities are being measured, have now been characterized by chemical analysis, density measurement, crystallographic structure, electron micrographic examination and x-ray diffraction measurements. In addition, normal spectral emissivities of ZrB_2 and NbB_2 have been measured between 1536 and 2289°K. Results of NbB_2 emissivity measurements only are given, since ZrB_2 data thus far are somewhat erratic and irreproducible. (auth)

16633 (AD-296341) DESIGN DATA STUDY FOR COATED COLUMBIUM ALLOYS. Final Summary Technical Report, December 21, 1961 through December 21, 1962. J. D. Gadd (TAPCO. Div. of Thompson Ramo Wooldridge Inc., Cleveland). Jan. 21, 1963. Contract NOw 62-0098-c. 118p. (ER-5185)

Design data properties were determined for two protective-coating–niobium-alloy systems involving Pfaudler and TRW oxidation protective coatings on Fansteel-85 niobium alloy up to temperatures of 2600°F. Prior to the design data study, preliminary screening oxidation, bend and prestrain tests were conducted on seven oxidation protective coatings applied to D-14 and FS-85 niobium alloys. Based on the screening test results, Pfaudler and TRW coatings were selected for the mechanical properties evaluation. The following design properties were determined for uncoated and Pfaudler and TRW coated 30 mil FS-85 alloy sheet: coating cyclic oxidation protective life, tensile properties of uncoated (in vacuum) and coated (in air) sheet, coating deformation tolerance, and stress rupture properties of coated sheet (in air). (auth)

16634 (AGN-8063) DETERMINATION OF TEMPERATURE COEFFICIENT OF SOLUBILITY OF VARIOUS METALS IN RUBIDIUM AND THE CORROSIVE EFFECTS OF RUBIDIUM ON VARIOUS ALLOYS AT TEMPERATURES FROM 1000 TO 2000°F. Topical Report, February 1, 1961 through July 31, 1962. Peter F. Young (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AT(04-3)-368. 101p.

Techniques were developed for determining the equilibrium concentration of various metals in rubidium and the corrosive effects of rubidium on selected commercial refractory and non-refractory metal alloys. The equilibrium concentrations of Nb, Zr, Mo, Ti, V, Ta, Fe, Be, Cr, and Ni in rubidium were determined over the temperature range 1000 to 2000°F. The corrosion of Mo–0.5 Ti, Nb–1 Zr, and Haynes-25 alloys and beryllium and vanadium metal by rubidium was determined at various temperatures from 1000 to 2000°F in 1000-hour tests. Equilibrium concentration and corrosion results are reported and evaluated. (auth)

16635 (ASD-TDR-62-427) PREPARATION AND CHARACTERIZATION OF HIGH-PURITY SINGLE-CRYSTAL BORON. Irving R. King, Gerald R. Taylor, Jr., Frank E. Wawner, Jr., and Claude P. Talley (Texaco Experiment Inc., Richmond). Feb. 28, 1962. Contract AF 33(616)-7884. 41p.

Crystalline B specimens about 3 to 4 mm in diameter and several cms in length were prepared by chemical vapor plating and subsequently floating-zone melted. X-ray-diffraction studies showed them to be the β-rhombohedral phase and single crystalline over most of the zone-melted portions. Electrical and optical measurements were made on some of the B single crystals produced. (auth)

16636 (ASD-TDR-62-765) THE THERMAL PROPERTIES OF TWENTY-SIX SOLID MATERIALS TO 5000°F OR THEIR DESTRUCTION TEMPERATURES. (Southern Research Inst., Birmingham, Ala.). Aug. 1962. Contract AF33(616)-7319. 420p. (AD-298061)

The thermal expansion, heat capacity, thermal conductivity, total normal emittance, electric resistivity, and thermoelectric voltage were investigated for 26 refractory materials, including the borides, carbides, nitrides, oxides, ATJ graphite, tungsten, and alloys of molybdenum and niobium. The temperature range was from 500 to 5000°F. In addition to these thermophysical properties, the density, chemical analysis before and after temperature exposure, and microscopic pictures before and after temperature exposure, are included to define the materials and assist in the analysis of the data. (auth)

16637 (BBC-115) DEVELOPMENT OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. Annual Report, January 1 through December 31, 1961. R. M. Paine, A. J. Stonehouse, and W. W. Beaver (Brush Beryllium Co., Cleveland). Sept. 1962. Contract AT(33-3)-20. 88p.

Investigations as to the nature of and the elimination of intermediate-temperature failure of the beryllides are described. The intermediate-temperature problem manifests itself in a number of ways, including poor oxidation resistance and poor strength and thermal shock resistance at intermediate temperatures. The temperature range over which the problems manifest themselves is dependent upon the particular material but is in the range of 1000 to 2000°F. Among the beryllides, the problems appear to be limited to the zirconium beryllides and, to a lesser extent, to the niobium beryllides. The role of impurities and various additive elements such as Fe, Ni, and Al is discussed. The addition of Al to $ZrBe_{13}$ to the extent of approximately 0.4% completely eliminates accelerated oxidation in the case of $ZrBe_{13}$. Possible mechanisms for intermediate-temperature failure are discussed. (auth)

16638 (BMI-1611) FISSION-PRODUCT MIGRATION IN AND RELEASE FROM IRON-20 w/o CHROMIUM.

Arthur A. Bauer, Josef Bugl, George G. Cocks, Thomas S. Elleman, James E. Howes, Jr., David L. Morrison, and Fitz R. Winslow (Battelle Memorial Inst., Columbus, Ohio). Jan. 25, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract W-7405-Eng-92. 51p. (EURAEC-582)

Both in-pile and out-of-pile experiments were performed in a study of rare-gas and solid-fission-product diffusion in a bcc Fe–20 wt % Cr alloy. Fission-gas-release measurements during postirradiation heating of recoil-impregnated foils showed that release is time, temperature, and concentration dependent. The time and concentration dependence was interpreted in terms of fission-gas clustering or bubble nucleation and growth, although other mechanisms are being considered. Evidence of fission-gas bubble formation was obtained by transmission electron microscopy. Release of fission-product gases during irradiation of clad fueled samples was low and exhibited a half life dependence. Precursor halogen diffusion may play a role in the observed gas release. Techniques for studying solid-fission-product diffusion were developed. Limited data for diffusion during postirradiation heating were obtained. Diffusion rates for Ru were much greater than the rates for Ce and Zr–Nb, which were similar. (auth)

16639 (DMIC-Memo-157) A COMPILATION OF THE TENSILE PROPERTIES OF TUNGSTEN. J. L. Ratliff and H. R. Ogden (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Sept. 11, 1962. 30p. (AD-283572)

Many factors affect the tensile properties of tungsten. These include such factors as starting material, fabrication history, strain rate during testing, and surface condition of the samples. Graphs showing detailed plots of the tensile properties of tungsten over the temperature range 0 to 6000°F are included to illustrate the scatter in properties that can be expected in tungsten over various temperature ranges. Except for the effects of strain rate and surface condition, the properties of tungsten fit within a fairly normal scatter band. Strength values usually fall within a band of ~±15,000 psi at the lower temperatures and a somewhat smaller band at the higher temperatures. (H.G.G.)

16640 (DMIC-Memo-164) A DISCUSSION OF THE FRACTURE TOUGHNESS OF SEVERAL STAINLESS STEELS IN SHEET FORM. F. J. Barone and A. M. Hall (Battelle Memorial Inst. Defense Metals Information Center, Columbus, Ohio). Jan. 31, 1963. Contract AF33(616)-7747. 31p.

Fracture toughness refers to the capability of a material to sustain high stress without failure in the presence of local stress raisers, such as notches and cracks. Fracture toughness data on eleven types of stainless steel sheet specimens are given in terms of such parameters as G_c and K_c, or in terms of the ratio of fracture strength either to yield strength or to ultimate tensile strength. G_c is defined as the strain-energy release rate required to maintain a fast-running fracture, while K_c is the critical stress intensity. Fracture-toughness data do not satisfy all the requirements for supersonic skin application, but do provide a means of assessing the notch sensitivity and toughness of potential skin materials. Fracture-toughness data clearly show that high degrees of fracture toughness are obtainable in a variety of stainless steels. High toughness is found in both the transverse and the longitudinal sheet directions and prevails at yield strengths from 150,000 to 250,000 psi. (H.G.G.)

16641 (DRI-2091) DETERMINATION OF THE NIOBIUM-RICH REGION OF THE TERNARY PHASE DIAGRAMS, NIOBIUM–TUNGSTEN–HAFNIUM AND NIOBIUM–TUNGSTEN–ZIRCONIUM. Quarterly Report No. 2, December 1, 1962 to March 1, 1963. Albert S. Yamamoto and Charles E. Lundin (Denver. Univ. Denver Research Inst.). Mar. 1963. Contract AT(11-1)-1092. 10p.

A study of the phase equilibria of the niobium-rich regions of the Nb–W–Hf and Nb–W–Zr ternary systems is being conducted with the following objectives: examine three isotherms in the temperature range from 1600 to 1000°C and at each temperature level, determine the terminal solid solution boundary, other phase boundaries, and identify intermediate phases which may be in equilibrium with the niobium-rich solid solutions. Metallographic examination, x-ray-diffraction analysis, and hardness measurement are being used to conduct this study. Melting of selected Nb–W–Hf ternary alloys was completed, but several key Nb–W and Nb–Hf binary alloys are yet to be melted. Two tentative isothermal diagrams at 1300 and 1100°C for the ternary system, Al–Nb–Zr, were constructed as a result of metallographic and x-ray-diffraction analyses. The hardness data of the ternary alloys in as-arc-melted condition and annealed at 1300 and 1100°C are also graphically presented. (H.G.G.)

16642 (EURAEC-524) PHYSICAL PROPERTIES OF UO_2 SINGLE CRYSTALS. Quarterly Report No. 5, October 1, and December 31, 1962. (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 063-61-10RDB. 24p. (R-2204)

Several runs were made to prepare single crystals of UO_2 for studies at CEN and for satisfying requests from other institutions. The gyration method for spheroidization of single crystals was improved. An equipment for the sintering experiments and for observation of the necks formed between the particles was constructed. In a first experiment, no sintering could be observed at temperatures below 1700°C. For the mass-spectrometric determination of the U_{235}/U_{238} ratio, a device was developed allowing the removal of parallel layers of a thickness of 0.1 μ. UO_2 single crystals (as grown, annealed, and irradiated) were studied by transmission electron microscopy. Observations of small dislocation loops, small angle boundaries, dislocations and fission tracks were made. The method developed for thinning UO_2 crystals was also applied to ferroelectric $BaTiO_3$. Some modifications were introduced to the apparatus for the low temperature measurements. A few determinations of the thermal conductivity at room temperature and at liquid nitrogen temperature were performed. The values obtained (0.210 watts cm^{-1} $°K^{-1}$ at 288°K and 0.061 at 77.8°K) confirm previous conclusions. The construction of the apparatus for high temperature measurements is still in progress. The Hall-effect measurements were extended to high-ohmic crystals. The absence of any Hall response indicates that the Hall mobility has to be smaller than 0.015 cm^2 V^{-1} sec^{-1} at room temperature. The thermoelectric power of three single crystals of UO_2 was measured between 170°K and 320°K with a slightly modified apparatus. From the sign of the Seebeck coefficient, it follows that the conduction in UO_2 is of p-type in the temperature region investigated. The curves show a rather constant value for the thermoelectric power as a function of the temperature. The study of the effects of neutron irradiation on the electrical conductivity of UO_2 was started. Preliminary results show a marked increase

in the resistivity, accompanied by a decrease in the activation energy. Pulse annealing experiments in irradiated UO_2 indicate that practically no annealing occurs between room temperature and 300°C. Another transport mechanism, "the tunneling mechanism", which could eventually explain the electrical behavior of UO_2, was studied. It is shown that tunneling of the charge carriers cannot account for the effects observed in UO_2. This is a new argument in favor of the occurrence of small polarons in UO_2. (auth)

16643 (EURAEC-548) SWELLING OF URANIUM. Quarterly Report No. 9, October 1 and December 31, 1962. (Mol, Belgium. Centre d'Étude de l'Énergie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 087-62-4RDB. 8p. (R-2203)

Some observations were made on cold-rolled and partially annealed α-uranium. The specimens were prepared by electrolytic thinning and polishing. An hypothesis concerning bubble growth is proposed. (auth)

16644 (EURAEC-561) THE DEVELOPMENT OF A NEW DETERMINATION OF THE DUCTILE-BRITTLE TRANSITION TEMPERATURE. Quarterly Report No. M-63-85-26150, October 1, 1962 and December 31, 1962. H. C. van Elst (Netherlands. Nijverheidsorganisatie, TNO, The Hague). Jan. 21, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 068-61-11-RDN. 49p.

Efforts to develop a method for the determination of the ductile-brittle transition temperature of steel are discussed. This method is based on the emission of stress waves by a running brittle fracture. The modes of dissipation of these stress waves are assumed to define the brittle ductile characteristics of the fracturing material. Experiments verified that the relative twinning frequency during fracture can be used as an indication of a change in the transition temperature. Small specimens at various temperatures were submitted to stress waves, simulating those emitted by actual brittle fractures, to determine their capacity as to twinning which will indicate their brittleness. It seems probable that, instead of the time consuming counting of twins, the measurement of the attenuation of these stress waves might provide an equally reliable and more practical method for determining transition temperatures. (H.G.G.)

16645 (EURAEC-568) FISSION GAS RELEASE FROM URANIUM DIOXIDE. Quarterly Progress Report No. 8, October–December 1962. (FIAT. Sezione Energia Nucleare, Turin). Jan. 31, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 011-60-9RDI. 14p. (FN-E-30)

The results of experiments that were performed using six C.E.A. and six C.N.E.N. UO_2 pellets for a determination of the fission gas retention ability of the specimens are presented. One experimental feature of the postirradiated annealing method was established, i.e., the dependence of the release rate parameter (D′) values on the burnup. As the exposure is increased, the apparent value of D′ decreases. In CNEN specimens, this decrease was a factor of ten for an exposure increase of 3.5 times; whereas, the apparent diffusion rates decrease for CEA specimens was a factor of ~100 for exposure increases of 3 to 5 times. A heating burst release was observed in most specimens with the diffusion controlled linear release beginning after 1.5 to 3 hours. The activity released during the initial burst was 50 to 90% of the total 6-hr release. Cooling bursts were observed in experiments run at 1730°C but only one cooling burst was observed in the numerous experiments performed at 1565°C. The occurrence of cooling bursts does not support the theory of a cooling burst resulting from a disproportionation of the specimen into UO_2 and U metal. (H.G.G.)

16646 (LADC-5330) THE MECHANICAL PROPERTIES OF ALPHA PLUTONIUM IN COMPRESSION. S. E. Bronisz (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 23p.

The effect of temperature, testing speed, and purity on the mechanical behavior of α Pu in compression was investigated. The results of the tests were generally similar to those previously reported except that specimen purity was observed to affect the results and a strain-aging reaction was also observed. (auth)

16647 (LADC-5363) THE CRYSTAL STRUCTURE OF Pu_3Co. Allen C. Larson, Don T. Cromer, and R. B. Roof, Jr. (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract [W-7405-eng-36]. 11p.

A Pu–Co ingot was prepared by arc melting and heat treated at 440°C for one week. It was impossible to obtain good quality crystals due to distortion caused by crushing, but crystals of usable quality were found. Lattice constants and intensities were measured using a single crystal orienter and scintillation counter. Crystallographic data, least-squares parameters, and interatomic distances in Pu_3Co is presented. (H.G.G.)

16648 (LADC-5373) THE CRYSTAL STRUCTURE OF BETA PLUTONIUM METAL. W. H. Zachariasen (Chicago. Univ.) and F. H. Ellinger (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract W-7405-eng-36. 27p.

β-Pu is monoclinic body-centered with 34 atoms per unit cell. At 190°C a = 9.284 Å, b = 10.463 Å, c = 7.859 Å, β = 92.13°, and the density is 17.70 gcm^{-3}. The space group is I 2/m. One set of two plutonium atoms are in centers of symmetry. Three sets of four plutonium atoms are in reflection planes, one set of four on twofold axes and two sets of eight in general positions. The thirteen parameters in the structure were determined to an accuracy of about 0.04 Å. The seven different kinds of plutonium atoms in the structure have coordination number of twelve, thirteen, or fourteen. The mean atomic radius is 1.60 Å for coordination number twelve. (auth)

16649 (LADC-5396) THE BEHAVIOR OF IRON–SILICON ALLOYS UNDER IMPULSIVE LOADING. E. G. Zukas, C. M. Fowler, F. S. Minshall, and J. O'Rourke (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 28p.

The Hugoniot curves were determined for Fe–Si alloys containing up to 7 wt % (13 at. %) Si. The pressure of the transition increased as the Si content of the alloy increased. Single crystals of 2.9 wt % Si–Fe were also studied. The pressure of the transition was not dependent on crystallographic orientation. All of the Neumann bands (mechanical twins) were attributable to the {112} planes but not all of the {112} planes showed twin markings. (auth)

16650 (NAA-SR-7696) A STUDY OF URANIUM CARBIDE AND CLADDING MATERIALS FOR HIGH-TEMPERATURE SODIUM-COOLED REACTORS. R. D. Hahn (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 15, 1963. Contract AT(11-1)-Gen-8. 32p.

Irradiation experiments were conducted to determine the irradiation performance characteristics of uranium monocarbide, exposed to high-temperature (~2000°F), high

heat flux (~10^6 Btu/hr-ft^2), high-burnup (~25,000 Mwd/MTU) operation. Hyperstoichiometric uranium carbide fuels have sustained maximum conditions of burnup and average central temperature of 24,000 and 10,000 Mwd/MTU at 1550 and 2150°F, respectively. Hypostoichiometric uranium carbide fuels were exposed to conditions of 1800°F average central temperature for a burnup of ~7000 Mwd/MTU. Fission gas release, in general, was low. Values for fuel dimensional increases were scattered, due to thermal or mechanical effects over the fuel column lengths, and could not be correlated with burnup or average fuel central temperatures. The fuel density decrease profile of the fuel length was similar to the burnup profile. Hyperstoichiometric UC/Na (or NaK) Type 304 stainless steel systems show excessive cladding carburization at fuel surface temperatures as low as 1000°F for an acceptable reactor residence time. Hypostoichiometric UC/Na Type 304 stainless steel systems are compatible at 1200 and 1600°F under isothermal conditions for at least 6400 and 3000 hr, respectively. For the latter system, it appears feasible to operate fuel elements at central temperatures of ~2000°F to burnups in excess of 25,000 Mwd/MTU. Niobium and zirconium alloys have shown promise as cladding materials for the utilization of hyperstoichiometric uranium monocarbide. Out-of-pile tests have shown that zirconium and niobium alloys are compatible with hyperstoichiometric UC to 1600°F. Zirconium alloys are strength limited above 1150°F. Niobium, while satisfactory from a strength standpoint at 1600°F, may be limited by nuclear considerations. (auth)

16651 (NAA-SR-Memo-1522) RECOVERY OF ELECTRICAL RESISTIVITY OF COLD WORKED THORIUM. C. J. Meechan (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 21, 1955. Contract [AT(11-1)-Gen-8]. 3p.

A discussion of the annealing behavior of cold worked thorium and a comparison with the annealing of proton irradiated thorium are presented. Two distinct electrical resistivity recovery states were found in cold worked thorium in the range 80 to 560°K. The first is centered at 275°K where ~5% of the induced damage is recovered and the other is centered at ~485°K where ~ a 25% recovery is effected. Slow but continuous recovery was observed throughout the remainder of the temperature range. Approximately 60% of the induced damage had recovered after the anneal at 560°K. Comparing the results with those of the irradiated specimen, ~75% of the induced radiation damage recovers through the room temperature state, but only ~10% recovers in this range in the cold worked specimen. (H.G.G.)

16652 (NP-12633) STUDY OF EFFECTS OF IMPURITIES ON THE MECHANICAL PROPERTIES OF NIOBIUM. Quarterly Progress Report No. 2, July 1, 1962 through September 30, 1962. Torleif Lindtveit, Paul Storvik, and Ingard Kvernes (Sentralinstitutt for Industriell Forskning, Blindern, Norway). Sept. 1962. 9p.

Results of an investigation of temperature dependence on the tensile strength of Nb single crystals in the temperature range 77 to 293°K are reported. The tensile strength is highly temperature dependent below 213°K, but only one of the crystals tested at 77°K failed by cleavage. A study of the recrystallization behavior of electron beam melted Nb was conducted. The time-temperature relationship for the beginning of recrystallization is described. (H.G.G.)

16653 (NP-12634) STUDY OF EFFECTS OF IMPURITIES ON THE MECHANICAL PROPERTIES OF NIOBIUM. Quarterly Progress Report No. 1, January 1, 1962 through March 31, 1962. Torleif Lindtveit, Paul Storvik, and Ingard Kvernes (Sentralinstitutt for Industriell Forskning, Blindern, Norway). Apr. 1962. 8p.

Recrystallization studies were conducted on pure Nb as a function of degree of formation, time, and temperature. The annealing behavior of Nb is of interest because of grain-size control and an insight into high temperature atomic mobility. Niobium has poor oxidation resistance above 400°C and even at pressures of 10^{-4} mm Hg, the metal readily oxidizes at 1200°C. Gas analysis on Nb was completed. Niobium samples were analyzed by vacuum fusion methods using baths of iron, nickel, or platinum. The most promising results were obtained with platinum baths. (H.G.G.)

16654 (ORNL-3398) THE EFFECT OF STRESS STATE ON HIGH-TEMPERATURE LOW-CYCLE FATIGUE. C. R. Kennedy (Oak Ridge National Lab., Tenn.). Mar. 21, 1963. Contract W-7405-eng-26. 25p.

A study of the behavior of Inconel at 1500°F under realistic dynamic stress states was performed to critically evaluate present criteria used to solve low-cycle fatigue problems and to demonstrate their applicability for the more complex situations. The relative agreement between the static complex stress-creep-rupture results and the low-cycle fatigue data is demonstrated. From the relationships developed for static complex stress-creep-rupture data, it is demonstrated that the magnitudes of the effects of stress state and frequency on low-cycle fatigue can be determined. (auth)

16655 (SB-62-62) SOLID STATE PROPERTIES OF BISMUTH AND TELLURIUM ALLOYS AND COMPOUNDS. An Annotated Bibliography. P. R. Stromer, comp. (Lockheed Missiles and Space Co., Sunnyvale, Calif.). Feb. 1963. 68p.

A bibliography of recent (1961 and 1962) literature encompassing the solid state properties of bismuth and tellurium, both pure and in combination with each other and related substances, is presented. A total of 133 abstracts are arranged alphabetically by senior personal author and a detailed subject index is provided. (H.G.G.)

16656 (TID-16475) METALLOGRAPHIC PREPARATION OF ZIRCALOY. M. R. Louthan, Jr. and C. E. Padgett (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Aug. 1962]. Contract AT(07-2)-1. 6p.

A method of mechanical polishing and chemical etching, which successfully reveals both the hydride platelets and the Zircaloy structure, was developed. The specimen was wet-ground for ~30 seconds each on 80-, 240-, 400-, and 600-grit abrasive wheels. After wet-grinding, the specimen was ground on damp 600-grit paper with little pressure. It was then rotated by hand on microcloth with a small amount of 6 μ diamond dust abrasive and ~½ ml of ethyl alcohol. The 600-grit scratches were removed in 30 to 45 seconds and no further polishing was necessary. The polished specimen was etched with a solution of 70 ml glycerine, 15 ml HNO_3 (69.7%), 10 ml HCl (37%), and 5 ml HF (48%) at room temperature. The specimen was first rinsed in 170 to 180°F water, and then etched by swabbing with cotton saturated with the etchant. The swabbing and rinsing were repeated until the surface appeared bright. (H.G.G.)

16657 (TID-16506) THE FORMATION OF POINT DEFECTS DURING PLASTIC DEFORMATION AND THEIR SUBSEQUENT ANNEALING BEHAVIOR. Howard K. Birn-

baum (Illinois Univ., Urbana). [1962]. Contract AT(11-1)-1110. 46p.

The formation of point defects during plastic deformation and their subsequent interactions with dislocations in high purity copper was studied using a low temperature strain aging technique. The point defect-dislocation interaction gave rise to a small yield point whose magnitude depended on the temperature and time of aging after deformation. The annealing kinetics indicated that two types of point defects were formed by deformation in concentrations which depended on the prestrain and prior history of the specimen. A mechanism for the point defect annealing was proposed to account for the experimental results and was used to calculate the diffusion activation energy of the defects in the lattice and along the dislocations. Based on this mechanism, the defects were tentatively identified as the interstitial and the di-vacancy. The temperature dependence of the yield point was examined and was shown to be consistent with an elastic interaction due to the dilatation around the point defects. The results indicated that the point defects retained their identity on arrival at the dislocation rather than becoming incorporated into the dislocation structure. (auth)

16658 (TID-18197) CsCl-TYPE COMPOUNDS IN BINARY ALLOYS OF RARE EARTH METALS WITH GOLD AND SILVER. Technical Report No. 12. C. C. Chao, H. L. Luo, and P. Duwez (California Inst. of Tech., Pasadena. W. M. Keck Lab. of Engineering Materials). Feb. 1963. Contracts AT(04-3)-221 and Nonr-220(30). 10p.

In binary alloys of silver with Sm, Tb, Ho, and Tm, and of gold with Y, Pr, Nd, Sm, Gd, Tb, Dy, Ho, Er, and Tm, intermediate phases containing stoichiometric proportions of the two metals were found to crystallize into the CsCl (B2) type structure. The lattice parameters of these phases are reported and a correlation was found between these lattice parameters and the trivalent ionic radii of the rare earth metals. (auth)

16659 (TID-18246) SHEAR TEST OF AGOT GRAPHITE. R. Michel (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Feb. 17, 1960. Contract AT(10-1)-925. 8p. (EGCR-STUDY-227-A)

A test for the determination of the ultimate shear strength of AGOT nuclear quality graphite was performed in a direction perpendicular to the axis of extrusion. Two specimens were tested to destruction and an average ultimate shearing stress of 2900 psi was determined. However, this value must be used with caution since these specimens were cut from the same block and probably are not representative of a large number of furnace heats. Physical properties of graphite vary with manufacturing conditions, raw materials, graphitizing temperatures, position in graphitizing furnace, extrusion direction, and position within the block. To obtain a truly representative value of shear strength, a large number of tests should be conducted. (H.G.G.)

16660 (TID-18252) SOME COMPUTER RESULTS IN THE DIRECT ITERATION SOLUTION OF THE ELASTOHYDRODYNAMIC EQUATIONS. R. J. Wernick (Mechanical Technology Inc., Latham, N. Y.). Feb. 1963. Contract Nonr 3729(00). 27p. (MTI-62TR38)

Results of a computer program to solve elastohydrodynamic equations for bearings are presented. The method of solution is applicable to moderately loaded cases. The results check and extend previously published isothermal cases. Also included is a highly accurate method for calculating film thickness profiles, correcting a previous erroneous method. The flexibility of the program permits its further use in obtaining solutions of the elastohydrodynamic equations including thermal effects. (auth)

16661 (TRG-Report-441) SOME ELASTIC SOLUTIONS TO THE PROBLEM OF THE RESTRAINED BOWING OF A FUEL ELEMENT. W. N. Miller (United Kingdom Atomic Energy Authority. Reactor Group, Springfields, Lancs, England). Dec. 4, 1962. 42p. (NPCC-FEWP/P.1118)

A fuel pin that is encastered at both ends will not suffer a deflection at any point along its length when subjected to a transverse temperature gradient which is either uniform or a linear function of axial distance along the pin. This and other methods of restraining bowing are discussed. The equations describing the deflection of an elastic beam subjected to a transverse temperature gradient and to various end conditions and intermediate restraints were obtained. These equations are interpreted in terms of fuel pin bowing. Analytical expressions are thus obtained which demonstrate the effects of fuel pin length, material, end support, and braces upon the maximum bow. The collection of solutions presented should prove useful in the determination of fuel pin bowing characteristics in future reactor systems. (auth)

16662 (UCRL-10332) A 41 KILOBARS TRANSITION IN YTTERBIUM. Harold Stromberg and George Jura (California. Univ., Berkeley. Dept. of Chemistry and California. Univ., Berkeley. Lawrence Radiation Lab.). July 1962. Contract W-7405-eng-48. 5p.

During a study on the effect of pressure on the electrical resistance of ytterbium, the transition pressure at room temperature was observed at 40 ± 2 kbars or 41 ± 2 kbars based on a bismuth 6–8 transition at 88 and 91 kbars, respectively. Ytterbium metal of 99.9% purity was extruded into wires of 0.003 in. dia., annealed at 400°C and bent into a circular arc, the center coinciding with the axis of the anvils. This procedure minimizes the pressure gradient in the system. The wire was mounted between AgCl discs in ½ in. Bridgman anvils. The resistance of the sample was determined by measuring the emf drop across the sample while a known fixed current was passed through the system. The resistance changed by a factor of ~14 in. going from the α to β phase. Although the transition was quite slow, no difficulty was experienced in locating the pressure at which the transition starts due to the change in sign of the pressure coefficient. A large hysteresis exists in the pressure-resistance behavior on decompression. (H.G.G.)

16663 (UCRL-10344) CRYSTAL STRUCTURE OF EUROPIUM TUNGSTATE. David H. Templeton and Allan Zalkin (International Business Machines Corp., San Jose, Calif.; California. Univ., Berkeley. Dept. of Chemistry; and California. Univ., Berkeley. Lawrence Radiation Lab.). June 5, 1962. Contract [W-7405-eng-48]. 20p.

The structure of $Eu_2(WO_4)_3$ was determined by single-crystal x-ray diffraction data. The crystals are monoclinic, space group C2/c, with a = 7.676 ± 0.003, b = 11.463 ± 0.003, c = 11.396 ± 0.005 Å, β = 109.63 ± 0.04°, Z = 4, d_x = 7.37 g cm^{-3}. The atomic arrangement may be described as a scheelite superlattice with ordered vacancies in the cation positions, but atoms are displaced by considerable distances from the scheelite locations. Each W atom has four oxygen neighbors at average distances of 1.74 or 1.78 Å. Some W atoms have a fifth neighbor at 2.19 Å. Each Eu atom has eight oxygen neighbors at an average distance of 2.43 Å. (auth)

16664 (UCRL-13064) ANALYSIS OF STRESS CONCENTRATIONS IN THIN SPHERICAL SHELLS. M. K. S. Rajan, J. Penzien, and E. P. Popov (California. Univ., Berkeley. Inst. of Engineering Research). Dec. 1962. For Lawrence Radiation Lab., Livermore, Calif. Contract UCX-2271. 160p.

The flexural behavior of thin spherical shells in the elastic range of stresses is discussed. Attention is restricted to cases in which the displacements under loading are of smaller order than the thickness of the shell. The class of problems considered is that of a loading which produces stress concentrations in the proximity of the loaded zone and in which deformations are small. Equations and solutions are presented for the elastic analysis of small displacements in thin spherical shells under bending. The use of the conical co-ordinate system transforms the spherical shell into a conical one. Solutions are accurate in a region closely approximating the corresponding actual spherical shell region and are valid in a shallow region around the point of tangency of the conical co-ordinate system to the spherical shell. Special design charts and tables applicable to specific problems which frequently arise in practice are presented. (H.G.G.)

16665 (EURAEC-363) DIFFUSION OF RARE GASES IN SOLIDS. PRELIMINARY RESULTS ON THE EVOLUTION OF XENON-133 FROM MIXTURES OF URANIUM CARBIDE AND GRAPHITE. Special Technical Report No. 7, November 11, 1961 to March 12, 1962. (Hahn-Meitner-Institut für Kernforschung, Berlin). Work Performed under United States–Euratom Joint Research and Development Program. Contract 064-61-8RDD. 24p. A translation.

Experiments for measuring the postactivation diffusion of Xe^{133} from a sintered mixture of UC_2 and graphite are described. They were conducted on sintered lumps prepared for the gas-cooled BBC-Krupp-Kugelhaufen reactor and whose composition is UC_{43}. In the range 800 to 1600°C, the samples were heated inductively by high frequency currents under a vacuum of 10^{-3} to 10^{-4} torr and the escaping Xe was measured discontinuously. When the temperature is raised by steps, the first step results in a spurt of Xe^{133} evolution but is not repeated when the temperature is raised again. A test made with a preheated sample did not introduce any marked change in the release of Xenon, even when repeated several times. An approximate evaluation of the activation energy for the diffusion can be determined. The method in which Xe^{133} is released from the $UC_2 + C_{43}$ test pellets is hardly reproducible. (H.G.G.)

16666 CRYSTAL STRUCTURE AND STABILITY OF REFRACTORY PHASES. Hans Nowotny (Univ. of Vienna). Advan. X-Ray Anal., 5: 13-32(1962).

A discussion is presented of some recent investigations on beryllides, borides, carbides, nitrides, aluminides, and germanides of transition metals as well as with combinations of these with special reference to hafnium and uranium compounds. The results are discussed within the general field of refractories excluding the class of typical oxides. An intense study has revealed the influence of metalloid impurities (for instance carbon, nitrogen, and oxygen on high-melting borides and silicides or nitrogen and oxygen on carbides, respectively). Very often small amounts of such metalloids introduced by preparation techniques, like hot-pressing, sintering, and powder-reaction methods may change the constitution of the system. (auth)

16667 SELECTED APPLICATIONS OF HIGH-TEMPERATURE X-RAY STUDIES IN THE METALLURGICAL FIELD. H. J. Goldschmidt (B.A.S. Group Research Centre, Birmingham, Eng.). Advan. X-Ray Anal., 5: 191-212(1962).

High-temperature x-ray powder photography has proved of great value in many directions in the metallurgical field. Some of the successes achieved and problems encountered using an established-type camera (British Unicam) for temperatures up to 1400°C are discussed. Specific case histories are given, chosed both for their own scientific interest and to illustrate the techniques employed. The applications concern phase transformations and the measurement of coefficients of thermal expansion in iron and steels, as well as in some nonferrous metals and inorganic compounds. (auth)

16668 DETERMINATION OF THERMAL EXPANSION BY HIGH-TEMPERATURE X-RAY DIFFRACTION. Dale A. Vaughan and Charles M. Schwartz (Battelle Memorial Inst., Columbus, Ohio). Advan. X-Ray Anal., 5: 238-43(1962).

Two high-temperature x-ray diffraction cameras are described which have been employed at Battelle to determine thermal expansion of metals and ceramic materials. Specimen preparation and temperature measurement and control are described. Lattice-parameter data vs. temperature are presented for uranium, uranium dioxide, and magnesium oxide. (auth)

16669 OBSERVATIONS OF PHYSICAL PECULIARITIES OF PLUTONIUM. C. Z. Serpan, Jr. and I. J. Wittenberg. Am. Soc. Metals, Trans. Quart., 55: 261-4(Mar. 1962).

Unusual physical occurrences exhibited by Pu as it expands and contracts under various heating and containment conditions were observed while determining the density of liquid Pu. Pu ruptured its containers and was extruded from them as it cooled from the liquid to the solid state transformations to room temperature. (P.C.H.)

16670 Gd_4Bi_3— A NEW FERROMAGNETIC COMPOUND. S. Methfessel and E. Kneller (International Business Machines Research Center, Yorktown Heights, N. Y.). Appl. Phys. Letters, 2: 115-16(Mar. 15, 1963).

Magnetic measurements on homologous compounds of rare-earth metals revealed Gd_4Bi_3 to be ferromagnetic below 340 ± 2°K. Preparation of the compound and its magnetic and structural properties are discussed. (D.C.W.)

16671 DETERMINATION BY ISOTHERMAL DILATOMETRY OF CURVES FOR THE BEGINNING AND END OF THE TRANSFORMATION OF URANIUM–CHROMIUM ALLOYS TEMPERED FROM THE β REGION. Michel Degois and Rene Faivre (Faculte des Sciences et E.N.S.M.I.M., Nancy, France and CEA, Saclay, France). Compt. Rend., 255: 3185-6(Dec. 5, 1962). (In French)

A low inertia recovery dilatometer was used to determine the TTT curves of uranium–chromium alloys with 0.37, 0.6, 2, and 4 at. % Cr. Tempering followed by isothermal recovery was the method used. The results obtained were compared with those obtained by White (J. Metals, 7: 1221(1955)) during experiments on stepped tempering. (tr-auth)

16672 EFFECT OF THE COOLING RATE ON THE TEMPERATURE FOR THE ONSET OF THE γ-β TRANSFORMATION OF URANIUM–NIOBIUM ALLOYS COOLED IN THE γ RANGE. Claude Collot and René Faivre (Faculte des Sciences, Nancy and CEA, Saclay, France). Compt. Rend., 256: 151-2(Jan. 2, 1963). (In French)

It is shown that niobium, as molybdenum, lowers the temperature for the onset of the γ-β transformation of ura-

nium and that this effect is more noticeable when the cooling is highest. This is valid for all cooling rates studied from 1 to 2000°C/min. (tr-auth)

16673 A RHOMBIC MODIFICATION OF BERYLLIUM FLUORIDE. Yu. M. Korenev, Yu. P. Simanov, and A. V. Novoselova (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 147: 846-8(Dec. 1, 1962). (In Russian)

Since the radii of Be^{2+} (r = 0.34 Å) and Si^{4+} (r = 0.39 Å), and also of F^{-1} (r = 1.33 Å) and O^{2-} (r = 1.32 Å) are close to each other, beryllium fluoride should have a structure similar to that of silicon dioxide (SiO_2). The decomposition of $(NH_4)_2BeF_4$ results in the formation of a cristobalite form of BeF_2 having a tetragonal lattice with conversion to a cubic modification at 130°C similar to the $\alpha \rightleftharpoons \beta$ conversion of cristobalite (SiO_2). Other modifications of BeF_2 similar to the low- and high-temperature modifications of quartz were found. A new modification of BeF_2 similar to tridymite was prepared from the quartz-like modification of BeF_2 by fusing a mixture of $(NH_4)_2BeF_4$ and $(NH_4)_3ZrF_7$ containing 4% ZrF_4, and by fuming off NH_4F at 300°C in a current of CO_2. The temperature was raised from 400 to 420°C to remove the last traces of NH_4F. The fluoride mixture containing 4% ZrF_4 was held at 590 to 600°C for 25 hours. X-ray analysis showed that this new modification of BeF_2 had a rhombic, body-centered lattice with a = 10.01 kX, b = 13.07 kX, and c = 16.24 kX. This modification of BeF_2 is similar to α-tridymite (SiO_2) which crystallizes in a rhombic syngony with a = 9.88 kX, b = 17.1 kX, and c = 16.3 kX. (TTT).

16674 THE MAGNETIC PROPERTIES OF U_2O_5. N. I. Blinova, G. A. Romanov, V. M. Solntsev, and Yu. M. Tolmachev (Koplin Inst. of Radium, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 147: 1112-3(Dec. 11, 1962). (In Russian)

The magnetic susceptibility of U_2O_5 was measured on two samples of U_2O_5 which were obtained by treating U_2O_3 with dilute sulfuric acid. Measurements were also run on UO_2 and on a sample of U_2O_3 used in the synthesis of U_2O_5 for purposes of comparison. The magnetic moment $\mu_{exp.}$ in Bohn magnetons was calculated from the data. The average magnetic moment of U_2O_5 was 1.74 which agreed well with a theoretical value of 1.73 due to the spin of a single unpaired electron. If it is assumed that U_2O_5 is a compound of the type $UO_2 \cdot UO_3$, the experimental data give a value of μ_s equal to 2.30 which differs significantly from a theoretical value of 2.83 for two unpaired electrons. Thus, the data show that U_2O_5 is a compound of pentavalent uranium. (TTT)

16675 THE KINETICS OF THE ANODIC OXIDATION OF NIOBIUM METAL. A. Ya. Shatalov and T. P. Bondareva (Voronezh State Univ., USSR). Dokl. Akad. Nauk SSSR, 147: 1137-40(Dec. 11, 1962). (In Russian)

Pure niobium metal undergoes anodic oxidation according to the following equation: $2Nb + 5H_2O \rightarrow Nb_2O_5 + 10H^+ + 10e^-$. The change in potential of the oxide layer at constant density was determined as a function of time in 1N H_2SO_4, H_3PO_4, HNO_3, and HCl. The potential in the oxide film increased with time, as can be seen from the following equation: $d\Delta\phi/dt = (r/\sigma B_+)\, i \ln (i/\sigma I_0)$. Here $\Delta\phi$ is the rise in potential of the growing oxide film; σ is a roughness factor; r is the volume of oxide; I_0 and B_+ are constants whose values depend on the type of electrolyte for a given metal; t is the time; and i is the current density. A plot of $d\Delta\phi/dt$ versus $i \ln i$ gave a straight line over a definite interval of potentials and current densities. A stationary state was finally attained where the rate of formation of the oxide film equaled its rate of dissolution in the electrolyte. As a rule, the greater the anodic current density, the higher the value of this limiting potential in the oxide film. Thus, the voltage was 6.0 volts at a current density of 2.6 $\mu A/cm^2$, and over 2.0 volts at a current density of 0.5 $\mu A/cm^2$. It may take days to attain the equilibrium potential. (TTT)

16676 THE ANISOTROPY OF THE ACTION OF ELECTRON- AND γ-RADIATION ON THE DEFORMATION PROCESS OF BRITTLE ZINC SINGLE CRYSTALS. O. A. Troitskii and V. I. Likhtman (Inst. of Physics and Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSR, 148: 332-4(Jan. 11, 1963). (In Russian)

It was found previously that a thin layer of Hg reduces the strength of Zn single crystals; the total irradiation of such amalgamated Zn crystals in a strong β-field lowers further the strength of the metal, causing fracture at the early stages of deformation. This problem was further investigated by directing a γ beam from a Co^{60} source, corresponding to 4.10^4 g-equivalent of Ra, and an electron beam with energy of 1 Mev from an accelerator onto the surface of Zn single specimens coated with about 5-micron thick Hg layer. A Polanyi apparatus was used for measuring the elongation of the specimens. It was found that exposure to the electron beam, and to a lesser extent, to the γ radiation, leads to the reduction of the elongated samples, resulting in a well-defined anisotropy as to the character of the damage, shown by embrittlement in the transversal direction and an increase of the plasticity in the lengthwise direction. A similar phenomenon was observed also in the absence of a surface-active layer, under conditions of cold brittleness at -196°C. (TTT)

16677 THE ULTIMATE STRENGTH OF A TITANIUM ALLOY BASED ON THE COMPOUND Ti_3Al AT 800°C. I. I. Kornilov and T. T. Nartova (Baikov Inst. of Metallurgy, USSR). Dokl. Akad. Nauk SSSR, 148: 644-6(Jan. 21, 1963). (In Russian)

The existence of the compounds TiAl and $TiAl_3$ was definitely established in the Ti-Al system which is interest for the preparation of heat-resistant alloys; it appears probable that the compounds Ti_6Al and Ti_3Al are also formed from the solid solution. In view of the effect of such compounds on the ultimate strength of alloy, this property and the mechanical properties of alloys lying in the range of the compound Ti_3Al were investigated, maintaining the stoichiometric ratio as additions were made to the system. Solid solutions forming alloys with the compound were included in the study. The specimens were prepared by arc-melting of the pure materials; they were annealed at 850°C for 1 hour, then tested by centrifugal bending method at 700°C. The results indicated that the pure Ti and the alloys in the range of the solid solution of α-Ti with Al are not sufficiently heat-resistant. Increasing the Al concentration to about that of Ti_6Al (8.5 wt % Al) resulted in a sudden decrease of the creep rate; this became even more marked in the range corresponding to Ti_3Al (16 wt % Al). The increase of the ultimate strength was due to alloying and to the formation of solid solution by Ti_3Al with other metals. The refractory properties of Ti_3Al are superior by a factor of about 1000 to those of pure Ti. They approach the properties of Ni base alloys, although their specific is only one-half of those alloys. (TTT)

16678 THERMAL CONDUCTIVITY OF ANISOTROPIC SOLIDS AT HIGH TEMPERATURES— THE THERMAL CONDUCTIVITY OF MOLDED AND PYROLYTIC GRAPHITES. Joseph Vardi and Michael Hoch (Univ. of Cincinnati). J. Am. Ceram. Soc., 46: 129-32(Mar. 1963).

A method was developed for the determination of the thermal conductivities of anisotropic solids under conditions of two-dimensional, steady-state heat conduction in a cylinder of finite length heated in vacuum by high-frequency induction and radiating heat to the surroundings. The method was used to determine the radial thermal conductivity, k_r, and the axial thermal conductivity, k_z, of molded ZT-type and pyrolytic graphite in the temperature range 1260 to 2200°K. For ZT-type graphite, $k_z/k_r = -0.101 + 2.002 \times 10^{-4} \times T$ (1260°K < T < 2200°K); for pyrolytic graphite, $k_z/k_r = 0.0376$ at 1817°K. (auth)

16679 EFFECT OF GRAIN BOUNDARIES ON DIFFUSION-CONTROLLED PROCESSES IN ALUMINUM OXIDE. A. E. Paladino and R. L. Coble (Massachusetts Inst. of Tech., Cambridge). J. Am. Ceram. Soc., 46: 133-6(Mar. 1963).

Oxygen ion diffusion coefficients in single-crystal Al_2O_3 are several orders of magnitude less than aluminum ion diffusion coefficients in polycrystalline Al_2O_3. In polycrystalline Al_2O_3, oxygen ion diffusion is enhanced by the presence of grain boundaries as in the chloride ion diffusion in the alkali halides. Creep and sintering of polycrystalline Al_2O_3 occur at a faster rate than is possible through control by lattice diffusion of oxygen; the rates are in fair quantitative agreement with cation diffusion. It is tentatively concluded that enhanced oxygen diffusion in regions adjacent to boundaries allows aluminum ion bulk diffusion to be rate controlling for these processes. The electrical conductivity in Al_2O_3 is too high to be related to either anion or cation diffusion and is predominantly electronic. (auth)

16680 THERMAL EXPANSION OF URANIUM PYROPHOSPHATE AND OF CERAMIC BODIES IN THE SYSTEM UO_2–UP_2O_7. Henry P. Kirchner, Kenneth M. Merz, and W. Richard Brown (Cornell Univ., Buffalo). J. Am. Ceram. Soc., 46: 137-41(Mar. 1963).

During an investigation of methods of predicting the thermal expansion of pure, single-phase ceramics, uranium pyrophosphate (UP_2O_7) was synthesized and the thermal-expansion properties were measured by the x-ray diffraction and dilatometer methods. The basis for the selection of UP_2O_7 is discussed. Cubic UP_2O_7 expands with increasing temperature up to 400°C. Above this temperature the material contracts so that the specimen returns to the room-temperature length at about 1000°C. Intermediate phases in the system UO_2–UP_2O_7 were prepared and the thermal-expansion properties were measured. Ceramic bodies in the system UO_2–UP_2O_7 were prepared. The thermal-expansion properties of these bodies are discussed in relation to the properties of the individual phases. (auth)

16681 THERMAL CONDUCTIVITY OF BERYLLIA CERAMICS FROM −200° TO 150°C. Maksymilian Burk (Coors Porcelain Co., Golden, Colo.). J. Am. Ceram. Soc., 46: 150-1(Mar. 1963).

Thermal conductivity measurements are reported for cylinders of ceramics containing 99, 98, and 96% BeO. The rest of the ceramics was Al_2O_3, MgO + CaO, or SiO_2. The results showed a maximum near −160°C, and this maximum was more pronounced for the 99% BeO ceramics than for 98 and 96% BeO. (D.L.C.)

16682 CAPPED END, THIN-WALL TUBE CREEP-RUPTURE BEHAVIOR FOR TYPE 316 STAINLESS STEEL. G. H. Rowe, J. R. Stewart, and K. N. Burgess. J. Basic Eng., 85: 71-86(Mar. 1963).

The creep-rupture behavior of 34 capped end, thin-wall tubular specimens was correlated with results for 54 uniaxial tensile specimens in tests at 1350, 1500, and 1650°F. Basic tests established isotropy in creep-rupture properties as well as metallurgical stability for the material used in the study. Significant correlations of creep rate, rupture life, and rupture ductility were established for the cases of stress ratios 1/0 and 2/1 in the biaxial tension quadrant. Data from tests at 1500°F were evaluated for a statistical argument. This same material was subsequently utilized in a high temperature structures research program to be reported separately. (auth)

16683 ELECTRICAL RESISTIVITY OF STABILIZED ZIRCONIA AT ELEVATED TEMPERATURES. J. M. Dixon, L. D. LaGrange, U. Merten, C. F. Miller, and J. T. Porter, Jr. (General Atomic Div., General Dynamics Corp., San Diego, Calif.). J. Electrochem. Soc., 110: 276-80(Apr. 1963).

The electric resistivity of stabilized zirconia of various compositions was measured by a four-probe technique in the temperature range 550 to 1200°C. Resistivities of fully stabilized compositions were found to increase with increasing additions of the stabilizing oxide, and the lowest resistivities appear to occur in materials stabilized with small cations. (auth)

16684 THORIUM PHOSPHATE PHOSPHORS. P. W. Ranby and Doreen Y. Hobbs (Thorn Electrical Industries Ltd., Enfield, Middx., Eng.). J. Electrochem. Soc., 110: 280-4(Apr. 1963).

Some thorium phosphate phosphors activated by a number of different elements are described. Most important of these are the Cu-activated materials, which show unusual fluorescent properties by emitting strongly in the orange when excited by short ultraviolet. Lower concentrations of Cu in the presence of Li gave the more usual blue emission associated with lower valent Cu activation of phosphates, while with Cu and Ag an emission occurred in the yellow. The fluorescent intensity of some of the materials was high, and their use in lamps is discussed. (auth)

16685 STRESSES IN ANODIC FILMS. D. A. Vermilyea (General Electric Co., Schenectady, N. Y.). J. Electrochem. Soc., 110: 345-6(Apr. 1963).

Stresses in anodic films produced on several metals were measured by clamping the upper end of a thin foil of the metal and observing the motion of the lower end through a telescope. The results show that the stress in all films was tensile at small film thickness. For most metals the sign of the stress was independent of formation voltage, but the stress in anodic films on Zr decreased steadily from strong tension at low voltages to strong compression at higher voltages. Except for films formed on Ta, the reproducibility was generally poor, variations of ±25% from specimen to specimen being typical. Stresses reported for Ta are reproducible to ±10%. Also, the stress with forming voltage applied was always more compressive than at zero voltage except for W where no effect of the applied field was observed. Assuming that each newly deposited layer is hydrated, it is hypothesized that as the layer becomes buried it is dehydrated by proton migration, producing tension in the film. (P.C.H.)

16686 ON THE ORIENTATION OF DISLOCATION LOOPS IN ALPHA-URANIUM. A. G. Crocker (Battersea Coll. of Tech., London). J. Inst. Metals, 91: 242-3(Mar. 1963).

The observations of Makin et al., on elliptical dislocations in thin foils of irradiated α-uranium are discussed in some detail. The energy of a dislocation loop is considered, and a plot of energy vs b/a (ratio of semi-minor

and semi-major axes of elliptic loop) is given for various ratios of minimum and maximum dislocation energies per unit length. The error of assuming an elliptical loop to be a circle is also plotted on the graph, and it is suggested that loops of a wide range of shapes are likely to arise, particularly noncircular loops in anisotropic materials. Some comments are given on the grouping of the deduced poles of the loop planes around {110} and {023}. (D.L.C.)

16687 CREEP DEFORMATION OF STOICHIOMETRIC URANIUM DIOXIDE. W. M. Armstrong, W. R. Irvine, and R. H. Martinson (Univ. of British Columbia, Vancouver). J. Nucl. Mater., 7: 133-41(Nov. 1962). (In English)

The plastic behavior of sintered uranium dioxide of stoichiometric composition was studied using a creep-in-bending method. The range of temperature from 1250 to 1400°C and stresses from 700 to 16,000 psi were covered in the investigation. Expressions describing the dependence of steady-state creep rates on stress and temperature were developed. Materials possessing sintered densities from 93 to 98% of the theoretical density were tested and some indication of the effect of pore structure on plastic properties was obtained. (auth)

16688 PREPARATION AND SOME PROPERTIES OF ARC-CAST PLUTONIUM MONOCARBIDE. O. L. Kruger (Argonne National Lab., Ill.). J. Nucl Mater., 7: 142-50 (Nov. 1962). (In English)

Plutonium-carbon alloys in the compositional range of 42 to 60 at.% carbon were prepared by arc melting and drop casting. Metallography, x-ray diffraction and chemical analysis were used to evaluate the alloys. Density, hardness, and thermal expansion were measured. Unexpected abrupt changes in the rate of expansion which could not be attributed to a phase change were observed in alloys with more than 46 at.% carbon. This effect which accounted for increases of two to four times the normal thermal expansion coefficient was removed on thermal cycling. (auth)

16689 INCREMENTAL COLLAPSE IN α-URANIUM SUBJECTED TO THERMAL CYCLES WHILE UNDERGOING CREEP. J. R. Kench, J. Chamberlain, and A. G. Young (English Electric Co., Ltd., Whetstone, Leicestershire, Eng.). J. Nucl. Mater., 7: 165-81(Nov. 1962). (In English)

Experiments are reported which were carried out in order to study the effects of temperature cycling upon α-uranium polycrystals undergoing steady-state creep. The results of these experiments are discussed in terms of the internal stresses generated by anisotropic expansion of individual crystals in the aggregate; a theory which was developed earlier is extended to cover the case of large temperature cycles when the physical properties of uranium polycrystals vary during the cycle. An analogy between this theory and Parkes' theory of thermally induced stresses in redundant engineering structures is pointed out, and it is shown that deformations caused by thermal transients may comprehensively be understood in terms of elastic cycling, shakedown and incremental collapse. (auth)

16690 THE DIFFUSION OF FISSION PRODUCTS FROM GRAPHITE. J. R. Findlay and T. F. Laing (Atomic Energy Establishment, Harwell, Berks, Eng.). J. Nucl. Mater., 7: 182-91(Nov. 1962). (In English)

The emission of fission products embedded in various graphites by fission recoil was studied by the post-irradiation annealing technique over the temperature range 500 to 1400°C. Detailed studies of the emission of Xe^{133} showed the release to be in two parts: an initial rapid release lasting for about 16 hours and a slow diffusion process. The fraction evolved by the initial process increases with the temperature of annealing. Values are given to define its magnitude and some discussion of its origin is given. The latter portion of the release is described by a diffusion coefficient obtained from the application of Fick's law of diffusion to the release. Activation energies for the diffusion of Xe^{133} have been calculated and the relation of the diffusion coefficients to graphite structure is discussed. (auth)

16691 INTERMETALLIC PHASES IN COMMERCIAL BERYLLIUM. H. P. Rooksby (General Electric Co. Ltd., Wembley Middx., Eng.). J. Nucl. Mater., 7: 205-11(Nov. 1962). (In English)

Several specially prepared beryllium–iron alloys and one containing aluminum in addition to iron were investigated by x-ray analysis. The results are used to explain structural changes which take place in commercial beryllium under different conditions of heat treatment. In the aluminum-bearing alloy a cubic phase, isostructural with Be_5Fe but of larger lattice parameter, was produced. This may be denoted as $Be_5(Fe,Al)$. It accounts for the cubic phase which several investigators have observed in commercial beryllium after aging. Cubic $Be_5(Fe,Al)$ goes into solution on heating commercial beryllium above about 850°C, but may be reprecipitated on ageing in the temperature range 600° to 800°C, provided solution treatment has not been too prolonged or at too high a temperature. Following a severe solution treatment, aging results in precipitation of Teitel and Cohen's hexagonal $Be_{11}Fe$ phase. Both intermetallic precipitates appear to maintain an ordered relation and coherence with the beryllium matrix. The orientation relationships between the hexagonal matrix, cubic $Be_5(Fe,Al)$, and hexagonal $Be_{11}Fe$ were identified. (auth)

16692 ELECTRON MICROSCOPE STUDIES OF GRAPHITIZATION AND DEFORMATION IN CARBON FILM. G. M. Jenkins, J. A. Turnbull, and G. K. Williamson (Central Electricity Generating Board, Gloucestershire, Eng.). J. Nucl. Mater., 7: 215-17(Nov. 1962). (In English)

Data were obtained on the graphitization process and deformation mechanism in thin graphitized carbon films prepared for electron microscopic studies. The changes in diffraction patterns after graphitization are described. (D.L.C.)

16693 THE PRECIPITATION OF URANIUM METAL IN URANIUM DIOXIDE SINGLE CRYSTALS. R. G. Robins (University Coll., Wollongong, New South Wales, Australia). J. Nucl. Mater., 7: 218-19(Nov. 1962). (In English)

Experiments on the oxygen-deficient phase in UO_2 are reported briefly. UO_2 compacts containing U metal additions were annealed at temperatures up to 2500°C and then either quenched or cooled slowly; the quenched compacts showed no second phase, whereas the slowly cooled compacts showed an extremely fine precipitate of U. Single crystals of electrolytic UO_2 which were heated to 1800°C show precipitation of U both on the surface and in the interior of the crystal. (D.L.C.)

16694 EFFECTS OF SIZE AND CHEMICAL INTERACTIONS. A. Blandin and J. L. Deplanté (Faculte des Sciences, Orsay, France). J. Phys. Radium, 23: 609-12(Oct. 1962). (In French)

The study of the electron structure of defects in metals shows the existence of oscillations in the electron density and electric potential around each impurity. This model is applied to some properties of metals and alloys as chemical energy of interaction, size effect, and compressibilities. It is predicted that these properties depend mainly on

the valency of the matrix. Experimental results are discussed in the cases of the monovalent metals (noble and alkali metals) divalent metals (Mg, Zn, Cd) and trivalent aluminum. They are in good agreement with the theory. (auth)

16695 THE RESIDUAL RESISTIVITY DUE TO DEFECT PAIRS. C. P. Flynn (Univ. of Illinois, Urbana). J. Phys. Radium, 23: 654-8(Oct. 1962). (In French)

Calculations were performed to determine the contributions of coherent and multiple scattering phenomena to the residual resistivity of defect pairs in a metal lattice. The theory was applied to vacancy and tin impurity pairs in gold where it is found that the isotropic changes are small, being of the order of 5% of the total resistivity due to the isolated defects. The anisotropy in the case of vacancy pairs at first and second neighboring sites is found to be considerable, in agreement with the results of calculations by Bross and Seeger using a different model. Both isotropic and anisotropic resistivity increments oscillate with period $k_F a/\pi$ and decays as a^{-2}, with increasing separation a of the defects. (auth)

16696 OPTICAL PROPERTIES OF Au–Ni ALLOYS. F. Abelès (Institut d'Optique, Paris). J. Phys. Radium, 23: 677-85(Oct. 1962). (In French)

The optical constants of Au–Ni alloys were obtained from measurement of the reflectance and transmittance of thin films prepared by evaporation in vacuum. The nickel concentration is deduced from the variation of the crystal parameter measured by x rays (Debye-Scherrer method). The d-c resistivity of the films was also measured. An absorption band in the infrared was found which is shifted towards shorter wavelengths when the Ni concentration is increased, the intensity of which appears to be a linear function of the concentration. For higher energies (up to 6.2 ev), a modification of the absorption bands of gold due to the internal photoelectric effect was found. The main peak and the absorption limit are displaced towards higher energies (about 0.05 ev/Ni atom %), whereas the intensity of the same peak decreases when nickel is added. (auth)

16697 TRANSITION METAL ALLOYS. W. M. Lomer (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Radium, 23: 716-20(Oct. 1962). (In French)

A particular interest in the properties of transition metal alloys at the present time is the problem of the occurrence of localized electron spins. There is also, particularly in the first period, the problem of ordered magnetic states. Recent work has established that suppression of localized spin may occur in materials with a high density of states at the Fermi level, through the agency of combining those conduction states (with their balanced spin occupation) with the local state favored by the impurity atom. The density of states, however, is not a sufficient discriminating parameter, and additional properties, such as the high susceptibility (e.g. Pd), play an important role in stabilizing magnetic atomic states. Ferromagnetism on the band model is favored by a high density of states, originating from the d-band. A high density of conduction states, however, suppresses spin moment on impurity atoms, by broadening the d-states considerably and favoring equal spin occupation. Very particular interest, therefore, attaches to the properties of alloys at concentrations where ferromagnetic behavior begins, such as vanadium–iron between 15% and 25% Fe. (auth)

16698 REVIEW OF THE ELECTRONIC SPECIFIC HEAT OF B.C.C. AND F.C.C. SOLID SOLUTIONS OF FIRST LONG PERIOD TRANSITION ELEMENTS. K. P. Gupta, C. H. Cheng, and Paul A. Beck (Univ. of Illinois, Urbana). J. Phys. Radium, 23: 721-6(Oct. 1962). (In English)

A review is given of the electronic specific heat vs. electron concentration for b.c.c. solid solutions, including new data for the systems V-Cr and Ti-V. The latter alloys show a maximum of γ at approximately 60% V. The electronic specific heat coefficients correlate well with the superconductive transition temperatures, according to the Bardeen-Cooper-Schriffer theory, with an interaction coefficient V independent of composition. It was found that the CsCl-type ordered alloys in the ternary TiFe-TiCo and TiCo-TiNi systems possess electronic specific heat values paralleling those for the b.c.c. Cr-Fe alloys at the same average electron concentrations. The electronic specific heat values for the b.c.c. alloys of transition elements with one another can be apparently described to a surprising extent in terms of a more or less rigid band, the degree of filling up of this band with electrons being determined essentially by the average electron concentration for the alloy. This appears to hold even in cases where the electron concentration is determined by averaging over three different atomic species. As found also for the alloy VFe, with a CsCl-type ordered structure, ordering causes little, if any, change in the electronic specific heat values of these alloys. New low temperature specific heat measurements with f.c.c. solid solutions in the Mn-Fe, Mn-Ni, Fe-Ni, V-Ni systems gave coefficients for the specific heat term linear in temperature, which are in some cases quite inconsistent with each other if interpreted as electronic specific heat coefficients. Consistent γ values were obtained for simple ferromagnetic alloys and for nonmagnetic alloys. For alloys where the simultaneous presence of both ferromagnetic and antiferromagnetic interactions is known from magnetic measurements, or may be considered as very likely, the measured γ values are anomalously high. It has been proposed by Marshall that a temperature-linear contribution to the low temperature specific heat can arise in instances where a sufficient number of spins are located in a near zero magnetic field. It appears from the results that this condition is often fulfilled in alloys having both ferromagnetic and antiferromagnetic interactions. As a result, in such cases the γ value measured at low temperatures comprises, in addition to the true electronic specific heat coefficient, also a magnetic component. Using only γ values obtained for simple ferromagnetic and for nonmagnetic alloys, the shape of the d-band for the f.c.c. solid solutions has been nevertheless successfully determined in the electron concentration range from approximately 8 to 10. (auth)

16699 FERROMAGNETIC PROPERTIES OF Fe AND Ni IN RELATION TO THEIR BAND STRUCTURE. R. Gersdorf (Universiteit, Amsterdam). J. Phys. Radium, 23: 726-9(Oct. 1962). (In French)

Several properties of the elements Fe and Ni can be correlated with each other by means of an empirical theory, which assumes that the atomic magnetic moment does not have a constant value in transition metals, but is thought to depend in these cases on temperature, volume, and external magnetic field. The properties in question are, among others, the field-dependent volume magnetostriction, the change of magnetization and Curie point with pressure, and the deviations of the temperature dependence of the saturation magnetization from the appropriate Brillouin curves. Variations of the atomic magnetic moment are estimated by incorporating localized magnetic moments into the electron band theory of the 3d-electrons. (auth)

16700 ELECTRON STRUCTURE OF NICKEL-BASED AND COBALT-BASED ALLOYS. APPLICATION TO THE INTERPRETATION OF THE MEASUREMENTS OF NUCLEAR MAGNETIC RESONANCES IN FERROMAGNETIC ALLOYS. F. Gautier. J. Phys. Radium, 23: 738-44(Oct. 1962). (In French)

The change $\Delta\rho(r)$ in electronic density produced in the d band of nickel or cobalt by an impurity atom is computed. The structure assumed for the d bands of pure metals is deduced from tight binding computations by a development in the wave vector near to the top of the bands. $\Delta\rho(r)$ is found to be highly anisotropic; it is localized on the (100), (010), and (001) atomic planes which contain the impurity atom, and oscillates with increasing distance r with an amplitude decreasing as r^{-2}. In ferromagnetic alloys, this change in electronic density produces a long range magnetic moment of sign alternating with increasing distance. This effect should produce a singularity in the magnetic form factor for neutron scattering; the singularity actually observed in NiFe alloys might be due in part to this effect. These changes in d magnetic moments affect the effective fields measured in the matrix; it is supposed that the magnetic moment of an atom and its effective field are proportional and theoretical effective fields are found which are of the same order of magnitude as experimental data from nuclear magnetic resonance. (auth)

16701 A NEW ORDER-DISORDER TRANSITION IN Fe–Ni (50-50). J. Paulevé, D. Dautreppe, J. Laugier, and L. Néel (Centre d'Etudes Nucleaires, Grenoble, France). J. Phys. Radium, 23: 841-3(Oct. 1962). (In French)

Neutron irradiation experiments under magnetic fields on Fe–Ni alloys (50-50) have led to discovery of a new order-disorder transition of the type Au Cu of which the critical temperature is 320°C. The diffusion coefficient at temperatures of the order of 300°C being very low, the ordering can only be established under irradiation. The directing effect of the applied magnetic field due to the magnetic coupling of the bonds with the magnetization favors the development of the tetragonal axis in the direction of the field for the crystallites whose [100] axis lies in the neighborhood of the direction of the field. A study on the single crystal shows that this tetragonal axis is the only axis of easy magnetization in the ordered structure. (auth)

16702 NEUTRON DIFFRACTION STUDY OF k PHASE Cu–Mn–Al ALLOYS. Hisao Katsuraki, Hisao Takada, and Kazuo Suzuki (Nippon Telegraph and Telephone Public Corp., Tokyo). J Phys. Soc. Japan, 18: 93-6(Jan. 1963). (In English)

Neutron diffraction study of the atomic and spin arrangement of the κ phase of ternary alloys $Cu_{20}-Mn_{30+x}-Al_{50-x}$ (x = 0, 5, and 10) was performed. It is shown that, for alloys $x \neq 0$, excess Mn atoms replace Al atoms at body center sites of CsCl type crystal lattice, and their spins couple antiparallel with those at corner sites of the unit cell, confirming Tsuboya's model proposed to explain the results of magnetic measurements. (auth)

16703 MAGNETOSTRICTION AND ANOMALOUS THERMAL EXPANSION OF SINGLE CRYSTALS OF GADOLINIUM. R. M. Bozorth and T. Wakiyama (Tokyo Univ.). J. Phys. Soc. Japan, 18: 97-106(Jan. 1963). (In English)

Measurements were made with strain gages of the magnetostriction, λ, and the thermal expansion coefficient, α, of gadolinium single crystals from 4°K to above the Curie point. The four magnetostriction constants appropriate for a hexagonal crystal were evaluated, and special attention was given to the forced magnetostriction and its relation to the anomalous thermal expansion near the Curie point. By the use of the usual thermodynamic relations the results show that compressive stress when applied parallel to the hexagonal c axis reduces the molecular field, as in iron, and when applied parallel to the a axis it increases the molecular field, as in nickel. The anomaly in the thermal contraction is unusually large in the c direction. Both λ and α were also measured for polycrystalline material. (auth)

16704 MAGNETIC PROPERTIES OF IRON–BERYLLIUM COMPOUNDS WITH HEXAGONAL STRUCTURE. Keizo Ohta and Yoshikazu Kobayshi. Kobayashi Rigaku Kenkyushu Hokoku, 11: 61-4(July-Sept. 1961). (In Japanese)

Polycrystalline specimen (beta-phase) Fe-Be compounds were prepared with 71.0 and 68.0 at. % Be in vacuum induction furnace. Data are given for crystallographic and magnetic properties and magnetic anisotropy, including temperature levels in °K, Curie temperature, and °C, liquid O level, and the system phase diagram. (P.C.H.)

16705 POSSIBILITIES FOR PRACTICAL APPLICATION OF SUPRACONDUCTIVITY. E. Saur. Metall., 16: 380-5(May 1962). (In German)

Data are given for supraconductive properties, such as transition temperature and magnetic properties, in the supraconductive temperature range of Nb and Nb–Zr, Nb–Sn, and Mo–Re alloys. A review of technical applications is also included. (Rev. Metal Lit., 19: No. 7, 1962)

16706 INVESTIGATION OF COPPER–ZIRCONIUM ALLOYS. PART I. DETERMINATION OF THE SOLUBILITY OF ZIRCONIUM IN VERY PURE COPPER. U. Zwicker. Metall, 16: 409-12(May 1962). (In German)

Ultra pure Cu was produced by three-fold electrolysis. An investigation of the solubility of Zr in Cu at 400 to 900°C was made by metallographic techniques with measurement of electrical conductivity and hardness. (P.C.H.)

16707 METALLURGY AND APPLICATION OF ZIRCONIUM. D. Volokhoff. Metallurgie (Paris), 94: 247, 249-51, 253(Mar. 1962). (In French)

Zirconium and Hf are produced by carbidization, melting, and acid dissolution and melting of zircon or baddeleyite ores with fluosilicate to form Zr salts, then fractional crystallization or TBP extraction to separate Zr and Hf and subsequent electrolysis of melted salts, and application of Kroll or van Arkel methods to obtain pure Zr. The corrosion resistance, mechanical, thermionic, chemical, and physical properties of Zr and Hf used for nuclear reactors, electronic, and chemical processing equipment are also given. (P.C.H.)

16708 INVESTIGATION OF THE STRUCTURE OF THE TUNGSTEN CARBIDE WC BY NEUTRON AND X-RAY DIFFRACTION AND COMPARISON WITH SOME OLDER DATA. Erwin Parthe and Varadachari Sadagopan. Monatsh. Chem., 93: 263-5(1962). (In Italian)

Investigations were made on WC samples containing 50% W, 49.3% C, 0.006% O, 0.001% N, and up to 1% free C by neutron diffraction using a monochromatic beam of slow neutrons and x-ray diffraction. (P.C.H.)

16709 KNIGHT SHIFTS IN NIOBIUM–MOLYBDENUM ALLOYS. S. Alexander, E. Corenzwit, B. T. Matthias, R. G. Shulman, and B. J. Wyluda (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 129: 2481-2(Mar. 15, 1963).

Measurements of the Knight shift of Nb^{93} in Nb–Mo al-

loys are reported. For alloys containing less than 40 at. % Mo, the shift is equal to the Nb metal shift of 0.83%. For higher Mo concentrations, the shift decreases linearly with concentration to a value of 0.057% at 95 at. % Mo. The possible meaning of these results and their relation to other measurements on these alloys are discussed. (auth)

16710 PHASE EQUILIBRIUM IN THE SYSTEM W–Nb–Si AND SOME PROPERTIES OF ALLOYS. N. V. Dokukina and F. I. Shamrai. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 6, 32-41(Nov.-Dec. 1962). (In Russian)

Metallographic and x-ray structural analysis methods and measurements of the hardness and microhardness of phases were used to study the structure of W–Nb–Si alloys. A phase diagram was constructed of the pseudobinary section of WSi_2–$NbSi_2$ in the form of a diagram with a eutectic of WSi_2 + $NbSi_2$, a solid solution containing ~60 at. % WSi_2 and melting at 1860°C. The triangulation of the ternary system W–Nb–Si is indicated, and its phase diagram was constructed. Four regions of ternary solid solutions were found and approximately outlined in the ternary system on the basis of the compounds $NbSi_2$, Nb_5Si_3, Nb_4Si, and W–Nb. Alloys of the WSi_2–$NbSi_2$ system are not refractory. On heating in air to 1100–1200° they become coated with a loose film of oxides, which do not prevent the further oxidation of the alloy surface. (auth)

16711 SOME DATA ON THE TERNARY SYSTEM TITANIUM–BORON–CHROMIUM. T. F. Fedorov, N. A. Nedumov, M. D. Polyakova, and F. I. Shamrai. Poroshkovaya Met., Akad. Nauk Ukr. SSR, No. 6, 42-9(Nov.-Dec. 1962). (In Russian)

It is shown that at room temperature one-phase fields occupy a very small area of the concentration triangle. This is in the small regions of solutions in a base of Ti, Cr, B, binary and possible ternary chemical compounds, as well as the continuous series of solid solutions on the base of diborides of Ti and Cr. It is probable that there are three-phase fields of Ti–TiB–$TiCr_2$, such as Cr intermetallic compound of Ti with Cr–boride. (P.C.H.)

16712 AN EXPERIMENT TO COMPARE THE EFFECT OF ELECTRON BEAM MELTING AND INERT GAS ARC MELTING ON THE CHARACTERISTICS OF SEVERAL REFRACTORY METALS. Yoshitsugu Mishima, Yozo Kurihara, and Naoaki Takahashi. Sogo Shikensho Nempo, 20: 225-34(Sept. 1961). (In Japanese)

The effect of the melting technique on the work hardening properties of cold-rolled Hf, Zr, Ti, Fe, and Ta sheet is presented, along with the metallographic analysis of specimens after annealing at 750 to 1200°C and the gas analysis of ingots. (P.C.H.)

16713 CONCERNING THE EFFECT OF ELECTRON BOMBARDMENT ON THE ADSORPTION PROPERTIES OF TUNGSTEN SURFACES. Yu. S. Vedula, V. M. Gavrilyuk, and V. K. Medvedev (Inst. of Physics, Kiev). Soviet Phys.-Solid State (English Transl.), 4: 1870-2(Mar. 1963).

The effect of a preliminary electron bombardment of a tungsten surface on the temperature dependence of the work function for the adsorptive systems Ba–W and U–W is investigated. It is shown that the differences between these dependences observed for surfaces that have and have not been subjected to the electron bombardment cannot be related to a combined adsorption of residual gas molecules and the Ba and U atoms. (auth)

16714 OPTICAL CONSTANTS OF LaB_6 AND CeB_6. B. M. Tsarev and S. V. Illarionov (Moscow Inst. of Physics and Tech.). Soviet Phys.-Solid State (English Transl.), 4: 1908-10(Mar. 1963).

An investigation was conducted to determine the energy spectra of LaB_6 and CeB_6 from their optical constants. The following constants were measured in the 1 to 22μ range: reflectivity, refractive index, absorption constant, and absorption coefficient. It is concluded that LaB_6 exhibits superconducting properties and has a forbidden band of finite width (~0.08 ev). CeB_6 exhibits metallic properties, and a weak absorption coefficient maximum near 15.5μ indicates a possible forbidden band. The results are interpreted in terms of electronic arrangements. (D.L.C.)

16715 BERYLLIUM COMPOUNDS. W. C. Riley and J. D. McClelland. Space/Aeronautics, 37: 74-7(May 1962).

The physical and mechanical properties of beryllia, Nb, Ta, and Zr, as affected by temperatures up to 2750°C, are tabulated. Discussion is given on applications of the refractories, which include re-entry designs, guidance, and electronic and nuclear systems. (P.C.H.)

16716 CHANGE IN THE COERCIVE FORCE AFTER ANNEALING OF DEFORMED NICKEL ALLOYS WITH ADDITIONS OF CERIUM, PRASEODYMIUM AND GADOLINIUM. Y. Ya. Dekhtyar and V. V. Polotnyuk (Inst. of Metallurgy, Academy of Sciences, Kiev). Ukr. Fiz. Zh., 7: 1324-34(Dec. 1962). (In Ukrainian)

It was shown that, on annealing alloys of nickel with Ce, Pr, and Gd deformed by torsion, two stages of change in coercive force are noted. The low-temperature stage is connected with the segregation of vacancies on dislocations; the high-temperature stage, with a decrease in the density of the dislocation during recrystallization. Proceeding from Vicena's theory of coercive force, relations are obtained describing the change in coercive force dedepending on the annealing time in the temperature region of the of the low-temperature and high-temperature stages. (auth)

16717 RUTHENIUM–VANADIUM ALLOYS. Ernst Raub and Walter Fritzsche (Forschungsinstitut für Edelmetalle und Metallchemie, Schwabisch Gmünd, Ger.). Z. Metallk., 54: 21-3(Jan. 1963). (In German)

The existence of two intermetallic compounds in the system ruthenium–vanadium, one of them having a pure, the other one a slightly distorted CsCl structure is proved to be true. The limits of the equilibrium regions of the saturated solid solution and the intermetallic compound are determined by means of x-ray and microscopic examinations. (auth)

16718 RESEARCH ON PRECIPITATION PROCESSES IN A NICKEL–CHROMIUM ALLOY WITH ADDITIONS OF ALUMINUM AND TITANIUM. Paul Schwaab and Kurt Hagen (Forschungsinstitut der Mannesmann A. G., Duisburg, Ger.). Z. Metallk., 54: 23-30(Jan. 1963). (In German)

The precipitation processes of an alloy containing 70.5 wt % Ni, 16.6 wt % Cr, 6.8 wt % Fe, 0.3 wt % Al, and 3.1 wt % Ti was examined by means of hardness tests as well as optical and electron microscopy. The experiments show that the hardening occurring after heat treatment at about 600 to 750°C is caused by metastable precipitations of the γ' phase, yet not by G.P. zones as in the case of Duralumin. Effects of coherence between γ' particles and the matrix are important. During long-lasting annealing the γ' phase disappears again, while the stable η phase precipitates. The course of this process is examined thoroughly, as is the precipitation of the chromium carbide, $M_{23}C_6$. (auth)

16719 INVESTIGATIONS ON THE ADSORPTION OF OXYGEN ON THIN TANTALUM LAYERS BY RESISTANCE

MEASUREMENTS. Erich Gebhardt, Hans-Dieter Seghezzi, and Horst Keil (Max-Planck-Institut für Metallforschung, Stuttgart). Z. Metallk., 54: 31-7(Jan. 1963). (In German)

Thin tantalum films were deposited at 90°K in a vacuum of 1×10^{-9} torr on the inner surface of a glass ball. Subsequently the electric resistivity of these films was measured with regard to oxygen pressure and temperature. When the films were heated to higher temperatures, an irreversible decrease in resistance due to an aging process occurred. The temperature coefficient of electric resistivity of the pure tantalum layers amounts to -2.9×10^{-4}/degree. During examination a constant oxygen pressure was maintained, the pressure varying between 2.4×10^{-7} and 2×10^{-3} torr. Increasing absorbed oxygen caused increasing electric resistivity. (auth)

16720 THE DEFORMATION OF ALUMINUM SINGLE CRYSTALS IN MULTI-CRYSTALLINE STRUCTURAL ASSOCIATION IN EXTRUSION PROCESSES. Walter Hueck and Guenter Wassermann (Institut für Metallkunde der Bergakademie Clausthal, Zellerfeld, Ger.). Z. Metallk., 54: 37-42(Jan. 1963). (In German)

Aluminum single crystals were embedded in aluminum extrusion billets and then deformed together with them by extruding and drawing. During this process the aluminum crystal always parts in deformation bands which have mainly a (111) direction parallel to the bar axis. If the initial orientation approaches the (100) direction, an increasing part of (100) deformation bands occur. Even if the initial orientation had a (100) direction the (111) orientation predominates. In the deformation bands the orientation of the extruded crystals changes continuously in relation to the cross section area. It is referred to the importance of the formation of deformation bands to understand the deformation textures of cubic face centered metals. (auth)

16721 THE TRANSFORMATION OF $\alpha + \beta$ TITANIUM ALLOYS WITH ALUMINUM. Hans Hermann Weigand (Forschungsinstitut der Deutsche Edelstahlwerke A. G., Krefeld, Ger.). Z. Metallk., 54: 43-9(Jan. 1963). (In German)

The transformation behavior of the titanium alloys Ti–6Al–4Cr, Ti–6Al–6Cr, Ti–7Al–3Cr, Ti–6Al–6Mo, Ti–7Al–4Mo, Ti–6Al–4V, and Ti–6Al–6V was studied during continuous cooling by the dilatometer. All alloys have a subcritical alloy content, the only exception being Ti–6Al–6Cr. The β phase transforms at high cooling rates into the α' phase, which decomposes on further cooling into a $\alpha + \beta$ mixed structure. The temperatures indicating start and end of the α' formation, start of the α' decomposition, and the critical cooling rate are lowered by increasing contents of Va, Mo, and Cr in this order. The transformation during quench and reheat treatments was investigated only for the Cr-containing alloys. The α' phase of Ti–7Al–3Cr decomposes completely during water quenching, the alloy Ti–6Al–4Cr contains, however, some untransformed portions of the α' phase. On reheating transformation processes take place both in the α and in the β phase. This can be illustrated by partial transformation diagrams. The transformation of the β phase by the precipitation of the α and γ_{Cr} phase corresponds to the reactions being known from investigations on Ti–Cr alloys without Al. At low temperatures, $\delta(Ti_3Al)$ phase precipitates from the α phase, whereas at high temperatures the $\gamma_{Al}(Ti_3Al)$ phase forms. In a small temperature region δ and γ_{Al} phase coexist. The activation energies for the formation of the δ and the γ_{Cr} phases correspond to the diffusion of Al and Cr. (auth)

16722 EXPERIMENTAL INVESTIGATION OF A SUPERCONDUCTING Nb–Zr ALLOY AT A FREQUENCY 9250 Mc/s. A. M. Kolchin, N. I. Krivko, and N. M. Reinov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 53-6(Jan. 1963). (In Russian)

Results of an investigation of the superconducting Nb–Zr alloy at a frequency of 9250 mc/s are presented. An anomalously large shift of the frequency of the cavity with the sample is observed in an external magnetic field; hysteresis phenomena and the effect of the frequency shift approaching its maximal value after several remagnetization cycles are also observed. These phenomena are apparently due to a change of the surface structure of the superconductor. (auth)

16723 MAGNETIC PROPERTIES OF SCANDIUM. V. I. Chechernikov, I. Pop, O. P. Naumkin, and V. F. Terekhova (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 387-9(Jan. 1963). (In Russian)

A chemical analysis of metallic scandium prepared by distilled calcium reduction of scandium fluoride from spectrally pure scandium oxide showed an admixture of: ≤0.116% O, ≤0.0074% H, ≤0.04% N, ≤0.07% Cu, ≤0.002% Mo, and ≤0.05% Co. An analysis of magnetic properties of metallic scandium annealed at 1000°C showed that at 77 to 1100°K temperature in ≈12000 Gauss magnetic fields, the scandium $1/\chi$ changes according to a linear law and $d\chi/dT < 0$. (R.V.J.)

16724 MATERIALS AND COMPONENTS IN SPACE ENVIRONMENTS. Francis J. Clauss (Lockheed Missiles and Space Co., Palo Alto, Calif.). Preprint Paper No. 63-58. New York, Institute of the Aerospace Sciences, 1963. 38p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Results obtained from studies to determine the limits of usefulness of materials and components for spacecraft systems and to discover new materials and techniques for extending the limits of performance were given. The techniques used in these studies were also given. (C.E.S.)

16725 THE INFLUENCE OF TEMPERATURE ON THE MECHANICAL PROPERTIES OF METALS AND ALLOYS. E. M. Savitskii (Savitsky). Translated by D. Sherby from Russian. Stanford, Calif., Stanford University Press, 1961. 311p.

In this book, an experimental and systematic examination is made of the influence of temperature on the mechanical properties of typical metallic systems in relation to the crystalline structure and the chemical interactions of the components. A basis is given for choosing the most favorable temperature conditions for hot working. Experimental data are presented for 20 metals, 15 metallic compounds, 16 binary systems, and 2 ternary systems, and conclusions are given in a final chapter for each group of metals studied. (D.L.C.)

16726 RESISTIVITY OF HEXABORIDES OF RARE-EARTH METALS. G. V. Samsonov and Yu. B. Paderno. p.102-7 of "Akademiya Nauk Ukrayins'koi RSR. Institut Metalokeramiki i Spetsial'nykh Splaviv. Vysokotemperaturnye Metallokeramicheskie Materialy [High-Temperature Sintered Materials]. Kiev, 1962."

It was found that the resistivity, ρ, of sintered hexaborides of several rare-earth metals depends on the degree of porosity. The resistivity of lanthanum hexaborides, for instance, increases from 15.9 μohm/cm at 3.5% porosity to 59.4 μohm/cm at 36.8% porosity. As a rule, the resistivity of the metal was found to be higher than that of the hexaboride, with the exception of Sm, Eu, and Yb, whose

resistivities (88, 81.3, and 27 μohm/cm) are lower than those of their hexaborides (207, 84.7, and 46.6 μohm/cm). The materials investigated may be used for cathodes operating under conditions of high current densities in low vacuum. Cathodes made of lanthanum hexaboride have a service life of 100 to 180 hr. (P.C.H.)

16727 NIOBIUM–TIN–ALUMINUM ALLOY STUDIES. Thomas Gordon Ellis. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1962. 101p.

A proposed constitutional diagram was developed from equilibrium data obtained for the Nb–Sn binary-alloy system. The equilibrium solubility of Nb in liquid Sn varied from approximately 250 to 2000 ppm at 580 and 1000°C, respectively. The equilibrium solubility of Sn in Nb varied from approximately 2.5 to 3 wt% Sn at 550 and 1000°C. Two previously unreported intermetallic compounds, Nb_2Sn_3 and Nb_3Sn_2, in addition to Nb_3Sn were found in the system. Nb_3Sn decomposed peritectically into Nb and liquid Sn at 2125 ± 25°C. Nb_3Sn_2 decomposed into Nb_3Sn and liquid Sn at 915 ± 5°C. Nb_2Sn_3, the assumed but unverified composition for the most Sn-rich compound, decomposed into Nb_3Sn_2 at 820 ± 3°C. Nb_2Sn_3 has a D_{2h}^{24}–Fddd structure with lattice parameters of 5.72 ± 0.04, 10.03 ± 0.06, and 19.06 ± 0.06 Å. Nb_3Sn_2 has a body centered orthorhombic crystal structure with lattice parameters of 5.637 ± 0.001, 9.204 ± 0.003, and 16.667 ± 0.003 Å. The number of possible space groups for Nb_3Sn_2 was reduced to four, D_2^8–I222, D_2^3–$2_12_12_1$, D_{2h}^{25}–Immm and C_{2v}^{20}–Imm. The intermetallic compounds Nb_3Sn and Nb_3Al were found to be completely miscible in the solid state. All of their alloys were simple cubic (Cr_3O type). Their lattice constants followed Vegard's rule except in the vicinity of mole ratios of 1:3 and 3:1. At these mole ratios the lattice constants deviated to values larger than predicted by Vegard's rule. Alloying Nb_3Sn with Nb_3Al appears to raise the zero field superconducting transformation temperature of Nb_3Sn slightly. (Dissertation Abst., Vol 23, No. 7)

16728 THE EFFECT OF HYDROGEN ON THE MECHANICAL PROPERTIES OF COLUMBIUM. Thomas Wendell Wood. Thesis, Norman, Okla., Univ. of Oklahoma, 1963. 179p.

The mechanical properties of Nb–H alloys, as a function of H content, temperature and strain rate, were investigated. H embrittles Nb even at concentrations below the limit of solubility. The concentration of H necessary to effect a given degree of embrittlement increases with increasing temperature in a roughly exponential manner. When not masked by a high ductile-brittle transition temperature caused by other factors (e.g., grain structure or other embrittling impurities), a restoration of ductility is observed at low temperatures. The ductility minimum occurs at about –78°C, which temperature appears to be that of H-strain aging during the tensile test. The embrittlement associated with the presence of H can be removed by vacuum dehydrogenation. H solubility in Nb increases with increasing temperature. The H concentrations necessary to cause embrittlement vary with temperature in a manner similar to that of the solubility but are somewhat less than the gross solubility. At H contents above the limit of solubility a second phase forms with a volume expansion of 10%. This expanded second phase constitutes prestressed Griffith crack on (100) planes and is the evident cause of embrittlement. At H concentrations below the limit of solubility, H is believed to segregate at microcrack vertices during plastic straining. The repulsive forces consequent to the segregation increase the stress concentration at the crack vertices. The applied stress required for fracture is thus lowered. It is found that the fracture stress of Nb decreases, with increasing H content, most rapidly at the strain-aging temperature. It is at this temperature, during straining, that H is delivered at a maximum rate to microcracks by the dislocations. (M.P.G.)

16729 ULTRASONIC SHEAR WAVE ATTENUATION IN SUPERCONDUCTING TIN. Jack Richard Leibowitz. Thesis, Providence, Brown Univ., 1962. 94p.

The superconducting attenuation of transverse ultrasonic waves was studied experimentally in Sn single crystals. The temperature dependence of attenuation was measured down to 1.1°K, for frequencies between 10 and 50 Mc/sec, as a function of propagation and polarization directions. In general, the attenuation was found to be separable into two regions, a sharply falling attenuation near T_c, the superconducting transition temperature, followed by a region of more gradual attenuation change with temperature. This latter "residual" attenuation was found to be consistent with the function $\alpha_s/\alpha_n \propto e^{-\epsilon/kT}$ at low reduced temperatures in Sn; α_s/α_n is the superconductive-to-normal attenuation ratio and ϵ is the temperature-dependent energy gap in the Bardeen, Cooper, and Schrieffer theory of superconductivity. This functional form satisfied the observations for all the principal propagation and polarization orientations. Anisotropy in the apparent superconducting energy gap was demonstrated in Sn from measurements of the temperature dependence of the residual superconductive attenuation. It was found that energy-gap anisotropy can be associated with polarization orientation as well as propagation orientation of the transverse ultrasonic waves. Observed values of total attenuation and residual attenuation were not consistent with free-electron theories, suggesting that real-metals effects play an important role in the coupling of shear waves to electrons in Sn. (Dissertation Abst., Vol 23, No. 7)

16730 IMPROVED MAGNESIUM ALLOYS. Geoffrey Charles Edward Olds (to Associated Electrical Industries Ltd.). British Patent 919,319. Feb. 20, 1963. Filed July 14, 1960.

Improved magnesium alloys are provided for use as canning materials for fuel elements that are greatly superior to the parent alloy. One alloy contains 0.6 wt% zirconium and 0.1 wt% manganese and another 0.7 wt% zirconium and 0.27 wt% manganese. The remainder of both are magnesium except for unavoidable impurities. (C.E.S.)

16731 THE SCREENING OF NEUTRONS AND RAYS. (to Elektroschmelzwerke Kempten GmbH). British Patent 920,128. Mar. 6, 1963. Priority date Sept. 2, 1958, Germany.

A shielding material for neutrons is described that comprises a neutron-absorbing filler having a high atomic absorption cross section for neutrons, mixed with an organic silicon compound (which is alone or mixed with a cellulose derivative). The shielding material can be boron, boron carbide, boron nitride, cadmium, hafnium, or mercury. (C.E.S.)

Radiation Effects

Refer also to abstracts 16882, 16883, 16884, and 16885.

16732 (AES-2) BESTRÅLNINGSFÖRÄNDRINGAR OCH NEUTRONATMOSFÄR I REAKTORTRYCKTANKAR—

NÅGRA SYNPUNKTER. (Irradiation Modifications and Neutron Flux in Reactor Pressure Vessels—Some Viewpoints). M. Grounes (Aktiebolaget Atomenergi, Stockholm). Sept. 1962. 33p.

Various aspects of the radioinduced modifications in reactor pressure vessels were considered. The general problem was first discussed, and then particularized to the R3 and R4 Reactors. Calculations were then made of the significance of neutron irradiation, and it was shown that the choice of the "damage model" can affect the computation of the pressure vessel dimensions by a factor greater than four. (tr-auth)

16733 (BMI-1621) ANNEALING STUDIES ON IRRADIATED TYPE 347 STAINLESS. William E. Murr and Frederic R. Shober (Battelle Memorial Inst., Columbus, Ohio). Mar. 6, 1963. Contract W-7405-eng-92. 49p.

The effects of 1-hr anneals at 1000 and 1800°F on the mechanical properties of Type 347 stainless steel specimens taken from the ETR J-10 pressure tube after fast-neutron (>1 Mev) exposures of $\sim 7.1 \times 10^{21}$ nvt were studied. The pressure tube operated at a maximum temperature of ~750°F in a stressed condition. Testing was done at 75 and 750°C. Uniform elongations were increased from ~1% in the as-irradiated material to 15 and 25%, respectively, by the 1000 and 1800°F anneals. The 1000°F annealing appeared to produce a better combination of mechanical properties. The microstructure of unirradiated, as-irradiated, and postirradiation-annealed specimens were very similar except for two specimens inadvertently heated above 1800°F during annealing. (auth)

16734 (CVNA-159) EFFECT OF IRRADIATION ON MECHANICAL PROPERTIES OF CVTR PRESSURE TUBE MATERIAL. W. R. Smalley (Westinghouse Electric Corp. Atomic Power Div., Pittsburgh). Sept. 1962. For Carolinas Virginia Nuclear Power Associates, Inc., Columbia, S. C. Contract AT(30-1)-2289. 78p.

As part of the program to establish the acceptability of extruded Zircaloy-4 for the CVTR pressure tube application, representative specimens were irradiated in low temperature process water in WTR to simulated two, three and five year service exposure. Integrated fast fluxes up to approximately 2.5×10^{21} nvt (>1 Mev) were accumulated. The effects of this irradiation were evaluated with respect to tensile properties at room temperature, 300, and 550°F; impact properties at room temperature, 200, 300, and 550°F; and creep at 550°F. Although the exposure conditions were more severe than those reported in other irradiation studies with Zircaloy (lower temperature and higher integrated flux) the property changes were comparable. It is concluded that the irradiation-induced changes in mechanical properties will not introduce any operational hazard to the CVTR pressure tube under anticipated operating conditions. (auth)

16735 (EXP-NRX-2807) IRRADIATION OF ZIRCALOY-2 CLAD UO_2 TO STUDY SHEATH DEFORMATION. R. D. MacDonald and A. S. Bain (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1962. 32p. (AECL-1685)

The irradiation of Zircaloy-2 clad UO_2 showed that in specimens with similar diametral clearances the axial expansion is more effectively controlled by dishing the pellet ends, than by assembling flat ended pellets with dished end plugs. Continued irradiation showed that 13 in.-long elements centered only at their ends can progressively bow until the coolant flow is restricted and failure occurs through accelerated corrosion of the Zircaloy-2 sheath. The amount of fission gas released varied with the heat rating, with less than 1% being released from an element irradiated at $\int_{T_s}^{T_0} k d\theta = 23$ W/cm and approximately 25% released if $\int_{T_s}^{T_0} k d\theta = 42$ W/cm. (auth)

16736 (GA-3872) RADIATION EFFECTS ON SILICON SOLAR CELLS. Final Report, December 1, 1961–December 31, 1962. V. A. J. van Lint, J. W. Harrity, H. Horiye, S. W. Kurnick, D. K. Nichols, D. P. Snowden, E. G. Wikner, and M. E. Wyatt, Jr. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Feb. 15, 1963. Contract NAS7-91. 132p.

Experiments were performed to study the defects introduced into Si by high energy (~30 Mev) electron irradiation. These defects are expected to be similar to those produced by high-energy protons. The diagnostic tools used include measurements of galvanomagnetic coefficients, excess carrier lifetime, electron-spin resonance, and infrared absorption. The results indicate that the A center in quartz-crucible-grown Si is not the primary excess-carrier recombination center. Instead, recombination in quartz-crucible-grown and floating-zone refined Si appears to be dominated by the same center. This center exhibits a strong dependence of the excess-carrier lifetime on excess-carrier density, with increasing lifetime at higher densities. The temperature dependence of the excess carrier lifetime appears to indicate an ionization energy of approximately 0.12 ev, and this same level is seen in the galvanomagnetic measurements. However, this activation energy may not be real, since there is a strong temperature dependence associated with the recombination cross sections. A variety of other energy levels were identified by the galvanomagnetic measurements and the rates of introduction of defects were measured. (auth)

16737 (GEAP-3927) VBWR IRRADIATION OF REACTOR CONTROL MATERIALS IN TUBES CONTAINING SIMULATED DEFECTS. F. H. Megerth and D. L. Zimmerman (General Electric Co. Atomic Power Equipment Dept., San Jose). June 1962. Contract AT(04-3)-189. 20p.

Samples of B_4C, $EuBO_3$, and TiO_2-stabilized Dy_2O_3, in pellet and compacted powder forms, were irradiated in the Vallecitos Boiling Water Reactor (VBWR). These neutron absorbing control materials were clad with 304 stainless steel tubes containing simulated defects. The effect of reactor exposure on pellet and powder stability was determined by measurements of sample weights and cladding dimensions, and by visual inspection of the irradiated absorber materials. The post-irradiation examination revealed no significant loss of materials or change in cladding dimensions. (auth)

16738 (GEAP-4081) PROGRAM FOR THE DEVELOPMENT OF PLUTONIUM RECYCLE FOR USE IN LIGHT WATER MODERATED REACTORS. Program Summary. Sixth Quarterly Report, July 1–September 30, 1962. J. G. Carver, W. R. Morgan, M. A. Robkin (General Electric Co. Vallecitos Atomic Power Lab., San Jose, Calif.); and M. P. Lagache (European Atomic Energy Community). Oct. 15, 1962. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 99p. (EURAEC-514)

The program fuel element achieved a burnup of about 790 Mwd/t at the center of the Pu-enriched segment, and a cumulative burnup of about 2430 Mwd/t. Analysis of data from gamma radiation scans of activated resonance wires is in progress. Calculations concerning the effects of thermal inelastic scattering in UO_2 on the fission rate and reactivity in fuel cells typical of the program fuel element

showed a fractional change on the order of ½ to 1% in the fission rate. Work on a THERMOS calculation of the detailed self-shielding of the Pu resonances was initiated. (J.R.D.)

16739 (GEAP-4107) HEAVY ELEMENT ISOTOPIC ANALYSIS OF UO_2 FUEL IRRADIATED IN THE VBWR. Report No. 1. M. R. Hackney and C. P. Ruiz (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Dec. 28, 1962. Contract AT(04-3)-189. 66p.

Slightly enriched UO_2 fuel, irradiated in the Vallecitos Boiling Water Reactor (VBWR), with exposures ranging from 100 Mwd/t to 3200 Mwd/t was analyzed for heavy element isotopic composition and compared with computed data. The primary objective of this program is to obtain improved data on the changes in nuclear characteristics with burnup of UO_2 fuel in a boiling water reactor. This information is important in both evaluating the economics of a given reactor design and also in providing a sounder physics basis for improving reactor designs to minimize the resulting fuel costs. Uranium oxide pellets, with an enrichment of 2.8 atom percent, were analyzed at several axial positions along the fuel rod, spanning the void (steam fraction) range of 0 to 30%. The isotopic composition for each pellet was computed, utilizing a general fuel cycle depletion code. Results of the analysis of the comparison of the measured and computed data indicate that the total amount of Pu computed is consistently lower than that implied from the measurement by approximately 10%, and the percentage difference between the measured and computed data increases slightly with exposure. One rod was irradiated near a control rod which was approximately 25% inserted. As expected, since no control rod effects were included in the calculation, the measured data in that region of the rod shows a greater Pu production per Mwd/t than computed. Physical effects which might explain the small, but apparently consistent, differences between the measured and computed data were postulated. It is concluded that the observed differences are the result of a substantial underestimate of void fraction and small uncertainties in fuel exposure and cross sections. (auth)

16740 (HW-76158) PROTOTYPE BURST TEST UNIT FOR IRRADIATED PRESSURE TUBES. P. M. Jackson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1963. Contract AT(45-1)-1350. 17p.

A bell-jar type pressure containment vessel was designed to enclose the specimen, blast shield, and furnace. This vessel excludes water from the hot specimen and furnace during testing and contains the pressure surge that occurs when the hot pressurized water in the specimen flashes to steam upon failure of the test specimen. Following cold testing, the prototype apparatus was installed in a small storage basin. To date, eleven sections of irradiated pressure tubes have been tested at a temperature of 280°C. Though initial difficulties were experienced in obtaining a uniform temperature over the tube length, it is now possible to maintain temperatures on a 20-inch specimen to within 5°C of an average temperature of 280°C. Special tools and jigs were developed to simplify the complex tasks of underwater assembly and disassembly of the test piece and installation of the test piece in the containment vessel. Several design modifications were developed as a result of the operation of the prototype unit. (auth)

16741 (HW-76228) METALLURGY RESEARCH OPERATION. Quarterly Progress Report, October–December 1962. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 15, 1963. Contract AT(45-1)-1350. 161p.

A report on the progress in metallurgy research operations at Hanford during Oct. to Dec. 1962 is presented. Primary emphasis was placed on determining the effects of neutron irradiation on the properties of specific metals containing known impurities and the effects of thermal treatments on the damage state of these metals. The effects of water and high-temperature helium environments on reactor metals are also explored. (H.G.G.)

16742 (NP-12628) EFFECT OF NUCLEAR RADIATION ON MATERIALS AT CRYOGENIC TEMPERATURES. Quarterly Progress Report No. 8, October 1962 through December 1962. (Lockheed Nuclear Products, Marietta, Ga.). Contract NASw-114. 63p. (ER-6102)

Progress made during Oct. to Dec. 1962 on the study of the effects of nuclear radiation on materials at cryogenic temperatures is discussed. The out-of-pile screening tests were completed during final installation of the various test equipment. The transfer system was aligned and checked out to determine its operating characteristics. The beam port shield was installed and pressure tests were conducted to ascertain the adequacy of the installation. Remote tools progressed in the fabrication phase and hot cave equipment was installed for further training. (H.G.G.)

16743 (TID-17682) A SURVEY OF 21 REACTOR VESSELS IN LIGHT OF THE ANTICIPATED EFFECTS OF NEUTRON IRRADIATION ON THE BRITTLE-RUPTURE PROPERTIES OF MATERIALS OF CONSTRUCTION. A. B. Holt (Division of Licensing and Regulation, AEC). [1962]. 102p.

The information available on the embrittlement of steel and the status of reactor vessels now in service is discussed. Topics covered include: the brittle-ductile temperature as danger indication, tests for ascertaining the brittle-ductile temperature, neutron flux measurements, surveillance and monitoring of reactor vessels, effect of temperature on the mechanical properties of metals, status of a selected number of reactor vessels, mechanical strength characteristics of steel as a basis for evaluation of the safety aspects of a pressure vessel, programs for surveillance of reactor vessels, probing a reactor vessel for increasing embrittlement, and the research and development program carried out in order to determine the effects of radiation on structural materials. (M.C.G.)

16744 (TID-18112) THE MECHANISMS OF FISSION GAS DIFFUSION IN GRAPHITE. Summary of Work Completed for the Period June 1, 1962–May 31, 1963. W. S. Diethorn and P. L. Walker, Jr. (Pennsylvania State Univ., University Park). Mar. 1, 1963. Contract AT(30-1)-2792. 31p.

A study of fission gas diffusion in graphite including the diffusion mechanism and its relation to graphite structure and history is described. The parameters of crystallite size and perfection, pores, degree of graphitization, and radiation damage to the graphite lattice are of chief concern. The diffusion study involves the measurement of fission gas release from graphite during postirradiation heat treatment. The study is restricted to the diffusion of Xe^{133} in graphite powders. (H.G.G.)

16745 (TID-18150) NEUTRON IRRADIATION EFFECTS IN A-286, HASTELLOY X AND RENE' 41. F. C. Robertshaw, J. Moteff, F. D. Kingsbury, and M. A. Pugacz (General Electric Co. Flight Propulsion Lab. Dept.,

Cincinnati). Sept. 24, 1962. Contract [AT(11-1)-171]. 55p. (TM-62-9-9)

The results of studies to determine the effect of neutron environment on the stress-rupture properties of A-286, Hastelloy X, and Rene' 41 are described. Specimens were irradiated in the ETR at ~540 and 650°C to fast neutron dosages of 4 to 11 × 10^{19} nvt ($E_n \geq 1$ Mev). Post-irradiation stress-rupture tests were conducted at 540 and 650°C. The effect of reheat treatment following irradiation was investigated. The results indicated that the stress-rupture strengths of A-286 and Hastelloy X at 540 and 650°C are significantly reduced by irradiation. A similar effect was observed in Rene' 41 at 650°C. Complete reheat treatment following irradiation did not restore the radiation induced loss in strength in A-286 at 540 or 650°C, or in Rene' 41 at 650°C. Reheat treatment appeared to effect recovery in the rupture strength of Hastelloy X at 540°C, but not at 650°C. The A-286 alloy showed substantial reductions in rupture ductility, particularly at 650°C. A similar loss in ductility in one of two heats of Rene' 41 was observed at 650°C. The ductility of Hastelloy X, though affected, remained at relatively high levels. Structural studies were initiated on control and irradiated specimens of A-286. Initial results are discussed. (auth)

16746 (TID-18253) RADIATION EFFECTS IN SOLIDS. [Progress Report], April 1, 1962–March 31, 1963. D. A. Wiegand (Carnegie Inst. of Tech., Pittsburgh). Feb. 8, 1963. Contract AT(30-1)-3033. 23p.

Measurements of several parameters indicate a significant microscopic strain due to point defect in irradiated alkali halides. These measurements are the increase in the average lattice parameter and the changes in the x-ray diffraction lines, the fractional increase in the thermal expansion coefficient, and the broadening and loss of intensity of the Na nuclear magnetic resonance line. The change in the x-ray diffraction line shape due to irradiation probably results from the following factors: a decrease in the size of the regions of coherence, a non-uniform distribution of defects, and a deviation of the strain field from the simple isotropic elastic continuum solution. The rate of generation of new F centers by irradiation at room temperature changes as a result of plastic deformation prior to irradiation. The dependence of the rate of defect generation on dislocation density is being investigated. An attempt to further clarify the distinction between F centers produced during irradiation from vacancies generated during deformation and the changed F generation rate due to a changed vacancy generation rate during irradiation is also being investigated. (H.G.G.)

16747 (VDIT-16(Ind.61/62)) RADIATION EFFECTS ON SOLID, URANIUM-BASED NUCLEAR FUEL MATERIALS. CUMULATIVE COORDINATE INDEX TO THE BIBLIOGRAPHY FOR THE PERIOD 1961/62. W. Uhlmann (Aktiebolaget Atomenergi, Stockholm). Jan. 1963. 23p.

A cumulative coordinate index to the bibliography for the period 1961 and 1962 concerning the radiation effects on solid, uranium based nuclear fuel materials is presented. (H.G.G.)

16748 THE EFFECT OF DISLOCATIONS AND DISORDERED REGIONS ON Co^{60} PHOTON INDUCED DEFECTS IN Ge. J. W. Cleland, R. F. Bass, and J. H. Crawford, Jr. (Oak Ridge National Lab., Tenn.). Appl. Phys. Letters, 2: 113-15(Mar. 15, 1963).

Plots of Hall coefficient vs inverse temperature for n-type Ge containing dislocations or fast neutron disordered regions and for dislocation-free Ge before and after Co^{60} photon irradiation indicate that the disorders can alter the energy level position of Co^{60} photon induced defect states. (D.C.W.)

16749 THE COMBINED EFFECT OF β-IRRADIATION AND A SURFACE-ACTIVE AGENT ON THE MECHANICAL PROPERTIES OF ZINC SINGLE CRYSTALS. O. A. Troitskii and V. I. Likhtman (Inst. of Physical Chemistry, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 147: 874-7(Dec. 1, 1962). (In Russian)

A thin layer of a surface-active metal such as mercury or gallium can cause a sharp decrease in the strength and plasticity of a more refractory metal such as zinc, tin or cadmium. Single crystals of zinc ~1 mm in diameter were covered with a thin film of mercury ~5μ thick, and were subjected to beta irradiation from a 100 mc P^{32} source. The sample was put under tensile stress during the irradiation. The samples amalgamated with mercury and subjected to beta irradiation for 7 days lost their strength and broke at ~20 g/mm^2 during the early stages of deformation at ϵ = 1 to 1.5%. The control samples which were treated with mercury but not irradiated showed a higher strength of ~200 g/mm^2, but broke along the basal plane at a slight elongation. It was found that there was a significant increase in strength and plasticity, if the amalgamated zinc single crystal was irradiated under tension at liquid nitrogen temperatures. Thus, metals can be increased in strength by amalgamating at relatively high temperatures, and then freezing in the defects by beta irradiation at low temperatures. (TTT)

16750 THE KINETICS OF THE POLYMORPHOUS TRANSFORMATION OF ZrO_2. B. Ya. Sukharevskii and I. I. Vishnevskii (Ukrainian Research Inst. of Refractory Materials, USSR). Dokl. Akad. Nauk SSSR, 147: 882-5(Dec. 1, 1962). (In Russian)

The time dependence of the $\alpha \rightleftharpoons \beta$ transition in ZrO_2 was followed by x-ray analysis on heated samples. The temperature was held constant at 1155 ± 1°C. The amount of monoclinic (α) and of tetragonal (β) phases in the sample at any moment of time was determined from the ratio of the observed intensity of a monoclinic or tetragonal line to the ratio of the intensity of this line in the single-phase ZrO_2. The sample was scanned at an angle of 13.5 to 15.5° in both directions at a rate of 1°/min. As low as 3% of the tetragonal modification could be detected. The rate of the $\alpha \rightleftharpoons \beta$ conversion was relatively slow at 1155°C and decreased as the sample was reheated. On heating the first time, the conversion was complete in ~35 minutes, but was incomplete after 3 hours of heating on the second reheating. From an analysis of the rate data, the limiting concentration of monoclinic phase associated with the tetragonal phase at 1155°C was 1.5% on the first heating, 15% on the second heating, and 20% on the third cycle. On completing the experiment, it was found that the grain size of the ZrO_2 had increased by a factor of 10. (TTT)

16751 UNSTABLE INTERMEDIATES. PART XIX. ELECTRON-EJECTION AND -TRAPPING IN MOLECULAR SOLIDS. M. C. R. Symons (Leicester Univ., Eng.). J. Chem. Soc., 1189-91(Feb. 1963).

Electron ejection and trapping in molecular solids is discussed in the light of electron spin resonance results for solids exposed to high energy radiation. An alternative interpretation of previous results is given in terms of a neutral radical. It was concluded that there is at present little in favor of such processes. (P.C.H.)

16752 HOW NEUTRON EXPOSURE ALTERS REACTOR STEELS. J. R. Hawthorne, L. E. Steele, and W. S. Pellini. Mech. Eng., 84: 64-5(May 1962).

Discussion is given on the effects of post-irradiation heat treatment on mechanical properties of reactor steels, pressure-vessel steels, ferritic steels, and a variety of plate, forging, and weld-metal compositions. (Rev. Metal Lit., 19: No. 7, 1962)

16753 POSSIBLE RADIATION DAMAGE EFFECTS IN BARIUM CHROMATE CRYSTALS. T. Adamski and L. Trojanowski (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Nature, 197: 1005-6(Mar. 9, 1963).

The formation of barium chromate crystals on isomorphous radium chromate nuclei was observed while precipitating barium chromate from solutions containing uranium and radium. The radioactive decay of the uranium caused marked radiation damage to the crystal structure. It is pointed out that traces of radium coming from uranium and thorium are always present in chromite ores. It was observed that reagent grade potassium chromate produces sediments of prismatic barium chromate crystallites having a rhombic cross-section. Possible radiation damage effects are discussed. (C.H.)

16754 ORGANIZATION AND ARRANGEMENT FOR IRRADIATION OF TEST PIECES IN WÜRENLINGEN. H. Albers, R. Haeberli, and Th. Huerlimann (Eidgenossischen Institutes fur Reaktorforschung, Würenlingen, Switzerland). Neue Tech., 4: 620-9(Dec. 1962). (In German)

The irradiation facilities of DIORIT and SAPHIR and for irradiations with γ rays are described. Details concerning the planning of experiments as well as the operational and safety regulations are given. Finally facilities for transportation of radioactive material are discussed. (auth)

16755 IRRADIATION CAPSULES FOR DRAGON FUEL ELEMENTS. F. Stierli (ETH, Würenlingen, Switzerland) and J. Trueb. Neue Tech., 4: 636-44(Dec. 1962). (In French)

The Swiss Federal Institute for Reactor Research received a contract for the design and manufacture of an irradiation experiment for DRAGON fuel samples. The conditions of irradiation in DIORIT are very similar to those foreseen in the DRAGON reactor. The fuel elements are enclosed in stainless steel capsules, with a double protection against leakage of fission products into the coolant circuit. Two cooling systems are provided: a heavy water and a secondary light water system. Temperatures up to 1200°C are measured by tungsten-tungsten/20% rhenium thermocouple. The maximum spine temperature for the first charge is 1400°C. (auth)

16756 HELIUM CIRCUIT FOR IRRADIATION OF FUSIONABLE MATERIAL AND FUEL ELEMENT COMPONENTS. P. Moser (ETH, EIR, Würenlingen, Switzerland). Neue Tech., 4: 645-50(Dec. 1962). (In German)

EIR is engaged in the design and construction of a helium-cooled in-pile loop for the irradiation of fuel elements. The lay-out of the loop as well as some design considerations, thermodynamical lay-out, control, safety aspects, are described. (auth)

16757 THRESHOLD FOR ELECTRON RADIATION DAMAGE IN ZnSe. B. A. Kulp and R. M. Detweiler (Aeronautical Research Labs., Wright-Patterson AFB, Ohio). Phys. Rev., 129: 2422-4(Mar. 15, 1963).

A threshold for the displacement of an atom from the ZnSe lattice by electron bombardment is observed at 240 kev. An electron of 240 kev transfers a maximum energy of 8.2 ev to the selenium atom and 10 ev to the zinc atom. The displacement is observed by the production at 85°K of a broad fluorescence band, which is resolvable into two overlapping bands with peaks at 5460 and 5850 Å. The radiation damage anneals completely at a temperature of 160°K. (auth)

16758 ENERGY DEPENDENCE OF PROTON DAMAGE IN SILICON. H. W. Simon, J. M. Denney, and R. G. Downing (Space Technology Labs., Inc., Redondo Beach, Calif.). Phys. Rev., 129: 2454-9(Mar. 15, 1963).

The defect density in silicon resulting from proton bombardment is calculated from 10 Mev to 1.8 Bev. The results show that Rutherford scattering of the protons dominates defect production at low proton energies. Above 50 Mev, recoil nuclei resulting from spallation contribute significantly to the damage process. Good agreement between theory and experiments at 95.5 and 450 Mev is found, using the change in short circuit current density of solar cells and the change in minority carrier diffusion length as the experimental measures of lattice defects. The experimental results indicate that earlier theoretical models describing the slowing down of ions cannot satisfactorily explain the present observations. (auth)

16759 COLOR CENTERS IN MIXED CRYSTALS OF ALKALI HALIDES. A. Smakula, N. C. Maynard, and A. Repucci (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 130: 113-19(Apr. 1, 1963).

Single crystals of KCl, RbCl, KBr and mixed crystals of KCl-RbCl, KCl-KBr, and RbCl-KBr of various compositions were colored by 3-Mev electrons with doses 10^4 to 10^6 rads at 20°, –80°, and –190°C. The influence of radiation dose, coloration temperature, and composition of mixed crystals on spectral position, half-width, and intensity of the V_1, K, F, F', and M bands was studied. At room temperature K, F, and M bands were produced, and at highest coloration N bands; only F and K bands appear at –80°C. At –190°C coloration the V_1, K, F, and F' bands appeared. In mixed crystals the spectral position of all absorption bands deviates from the Mollwo relation (vd^n = const). The deviation in V_1, K, F, and M is toward lower, and in F' toward higher energy. The half-width of all bands in mixed crystals is greater than in pure components except that of V_1 in the KCl-RbCl system, where it is smaller. The intensity of coloration in KCl-RbCl decreases with composition and reaches a minimum at molar ratio 1:1. In KCl-KBr and RbCl-KBr the intensity curves exhibit a relative maximum and a relative minimum. The behavior of the observed color-center bands is correlated to crystal structure and to the configuration of color centers. (auth)

16760 MATERIALS FOR NUCLEAR POWERPLANTS. John G. Fisher. Space/Aeron., 37: 75-9(Apr. 1962).

The effects of temperature and neutron irradiation on the physical and mechanical properties and microstructure of various materials including C, low-alloy steel, stainless steels, Zircaloy 2, Inconel X, 2024 Al alloy, U, graphite, Mo, W, TiC, ZrC, BeO, VO_2, VC, HfO, EuO, GdO, SmO, and ceramics are presented. (Rev. Metal Lit., 19: No. 6, 1962)

16761 INDUCED EMF AND DIELECTRIC STRENGTH IN X-IRRADIATED PVC. V. D. Kuchin and A. K. Shastova. Vysokomolekul. Soedin., 4: 1863-6(Dec. 1962).

The nature and behavior of induced emf and dielectric strength were studied for x irradiated poly(vinyl chloride). PVC samples were placed in a specially designed chamber and x irradiated at intensities of 50,000 to 150,000 r/min in doses of 10 to 10^8r at a sample temperature of 20 to 100°C. The induced emf (ϵ) was amplified and measured

with an error of ±16%. The measuring error for dielectric strength was ±25%. At a given temperature the emf increased with intensity; at a given intensity the emf dropped with a rise in temperature, log(emf) being a linear function of 1/T within the range investigated. The generation of induced emf was attributed to current carriers undergoing transitions to the metastable level to form a space charge of the ionic type. Addition to the PVC of plasticizer, which inhibits crosslinking under irradiation, did not change the shape of emf-versus-temperature curves but shifted them toward lower temperatures. The dielectric strength (E, kv/cm) increased with the irradiation dose (D, rad): at $D = 10$, $E \simeq 440$; and at $D = 10^6$, $E \simeq 550$. This was attributed to a decrease in the size of defects owing to crosslinking, as well as to the effect of the space charge. (OTS)

16762 CONDUCTIVITY AND PLASTIC BEHAVIOR OF COPPER AND SILVER WHISKERS UNDER α IRRADIATION. Peter Svoboda (Universität, Vienna). Z. Metallk., 54: 6-12(Jan. 1963). (In German)

Whiskers of Cu and Ag were produced by reduction of the chlorides of these metals. Optical and even electrical methods for determining the cross-section area being very inaccurate, a new method was developed. The whisker was made to vibrate as a string at its fundamental tone. From the frequency, tension, length, and density of the whisker, its cross-section area could be calculated. A new apparatus for tensile and flowing experiments is described. The stress applied to the specimen is produced by the weight of a horizontally lying bar, whose one end is suspended on the whisker and which is supported in another point beyond its center. The position of this point can be changed by a roll below the bar. In every position, the stress may easily be calculated. The increase of the specimen's length is observed by a microscope. The effect of α irradiation on the resistivity of the whiskers was measured at 90°K. As expected, an increase of resistivity resulted, which is in agreement with the theory as well as with experiments made with larger specimens. The flowing behavior appeared to be distinctly influenced by irradiation. The flow rate, vanishing under normal conditions, increased rapidly, when the irradiation began; some time later it decreased again and the flowing stopped. This effect, being contrary to those observed with big crystals, is interpreted by the formation of Frank-Read sources out of the point defects caused by irradiation in a nearly "ideal" material. (auth)

16763 DEISTVIE YADERNYKH IZLUCHENII NA MATERIALY. (Radiation Effects on Materials). S. T. Konobeevskii, ed. Moscow, Publishing House of Academy of Sciences, 1962. 383p.

Forty-three papers are included on the effects of nuclear radiation on materials. The data were previously presented at the Moscow conference, Effects of Nuclear Radiation on Materials, Dec. 6-10, 1960. Experimental studies of neutron radiation effects on reactor materials (steel, molybdenum, graphite, and Nichrome) are discussed, and theoretical evaluation was made of radiation effects on physico-chemical transformations, internal relaxation, internal friction, crystal structures, and electric, magnetic, and optical properties of dielectrics and semiconductors. (R.V.J.)

16764 IMPROVEMENTS IN AND RELATING TO RADIATION-RESISTANT LUBRICANTS AND THEIR USE. Neville John Hunter and Derek Illing (to British Petroleum Co. Ltd.). British Patent 920,509. Mar. 6, 1963. Filed Jan. 29, 1960.

A radiation resistant lubricant is described that is prepared by reacting p-triphenyl ether with an alkyl halide and/or an olefin containing up to 20 carbon atoms per molecule. (C.E.S.)

16765 IRRADIATION OF POLYMERIC COMPOUNDS. Donald A. Guthrie (to Esso Research and Engineering Co.). U. S. Patent 3,080,306. Mar. 5, 1963. Filed Oct. 30, 1959.

A method is given for reducing the molecular weight of polymers and copolymers of isobutylene for use as viscosity index improvers in lubricating oils. The method comprises irradiating a mixture of 1 to 95 wt % of the polymers and 99 to 5 wt % of a saturated halogen organic compound of the formula $C_aH_bX_c$, where a = 1 to 6, b = 0 to 13, and c = 1 to 14. (D.L.C.)

16766 IRRADIATED POLYMERS. Gaetano F. D'Alelio. U. S. Patent 3,082,161. Mar. 19, 1963. Filed Jan. 6, 1958.

A process is given for producing improved polyester resin compositions. The process comprises irradiating a linear, saturated aliphatic polyester with ≥2 Mrep of high-energy radiation in the presence of ≥0.1 wt % of a polyunsaturated ester. The various polyunsaturated esters which may be used in this process and examples of the process are given. (D.L.C.)

PHYSICS

General and Miscellaneous

Refer also to abstracts 15765 and 17402.

16767 (AAEC/TM-180) A GENERALIZED CRYSTALLOGRAPHIC STRUCTURE FACTOR PROGRAMME FOR THE IBM 1620 COMPUTER. A. W. Pryor and T. M. Sabine (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Feb. 1963. 9p.

Details are given of a program written in FORTRAN without format for an IBM 1620 computer, which computes structure factors for crystals of any symmetry. X-ray scattering factors are approximated to by exponential functions. L_p and temperature corrections are incorporated in the computations of the intensities of x-ray and neutron data collected by either the powder method or the equatorial plane method from single crystals. (auth)

16768 (AGN-8075) RUBIDIUM/CESIUM EVALUATION PROGRAM. Quarterly Progress Report, October 1 through December 31, 1962. C. R. Fisher and P. Y. Achener (Aerojet-General Nucleonics, San Ramon, Calif.). Jan. 31, 1963. Contract AT(04-3)-368. 35p.

The characteristics of Rb and Cs at temperatures up to about 2000°F are being investigated. The current program includes studies of the boiling heat transfer and two-phase flow characteristics, and measurements to determine the latent heat of vaporization, density, specific heat, viscosity, thermal conductivity, and electrical resistivity of the liquid phases of these elements. Work performed during the period is summarized. Results of the error analyses are given and details concerning the operating parameters for the heat transfer and fluid flow work are included. The apparatus to be used to measure latent heat of vaporization, specific heat, and density is also described. (auth)

16769 (AI-7979) SECOND ANNUAL TECHNICAL SUMMARY REPORT FOR BASIC RESEARCH IN THERMIONIC ENERGY CONVERSION. [Covering Period] November 1, 1961 to October 31, 1962. C. Warner, III, L. K. Hansen, H. Hori, and R. L. McKisson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Contract NONR-3192(00). 133p.

Results of work in a continuing program to investigate basic processes in thermionic energy conversion related to thermionic nuclear power plants for naval applications are reported. The areas in which progress is reported include statistical mechanics of Cs adsorption, space charge analysis for low pressure thermionic diodes, emission requirements for removal of space charge barriers, unignited mode of thermionic converters, interpretation of volt-ampere characteristics, vaporization and deposition at Cs-covered surfaces, and Cs purification. (auth)

16770 (ANL-6666) PHYSICS DIVISION SUMMARY REPORT, NOVEMBER–DECEMBER 1962. (Argonne National Lab., Ill.). Contract W-31-109-eng-38. 28p.

The error in an approximation relating an equivalent local potential to a nonlocal potential in optical-model calculations was investigated. The differential cross section and polarization for neutrons scattered from Cd at 0.45 Mev were calculated by the nonlocal optical model and two forms of the local optical model. Agreement of one local mode curve with the nonlocal curve was far better than for the other that used different well-depth parameters. Elastic proton scattering from Cu^{63}, Cu^{65}, Ni^{58}, and Ni^{60} was studied at proton energies of 7, 8, 9, 10, 11, and 12 Mev. Absolute cross sections were determined, and the angular distributions were compared with distributions calculated from an optical potential. Agreement became worse at lower energies because the statistical assumption of the optical model was not satisfied. Perey's prediction for the dependence of the optical model potential on neutron excess was shown to be consistent with experiment. Mass spectra of four magnesium halides were studied, and for each case 1% dimer and 0.01% trimer were observed. Heats of sublimation were measured by second-law and third-law methods, the third-law method yielding lower values. Heats of ionization derived from the data agreed well with ionic model calculations. The Regge trajectory as a function of the square of the momentum transfer in field theory was examined on the basis of the ladder approximation in the crossed channel. (D.C.W.)

16771 (ASD-TDR-62-1105) INVESTIGATION OF ELECTRODELESS PULSED PLASMA PROPULSION. Final Report, July 1961–November 1962. J. S. Luce, D. C. Gates, W. D. Day, J. F. Detko, O. D. Johns, and J. L. Wyatt (Aerojet-General Nucleonics, San Ramon, Calif.). Feb. 1963. Contract AF33(616)-8331. 132p.

Analytical and experimental investigation of electrodeless plasma accelerators as space propulsion devices was directed toward the determination of the nature of the field-plasma interaction and the over-all performance characteristics of electrodeless accelerators. An increasing phase velocity transmission line for the study of induction and synchronous modes of acceleration was designed and constructed. Measurements were made of the conductivity, density, and velocity of the plasma produced by a button source to be used with the transmission line. Diagnostic equipment was constructed for measuring plasma conductivity, density, temperature, and velocity. The button-type sources studied proved suitable for injecting into a transmission line and capable of producing a copper plasma with densities up to 10^{15}/cc and velocities in the area of 2×10^4 m/sec. Conductivities were in the range of 1000 to 1500 mho/m. Studies of the interaction of this plasma with the transmission line showed preferential trapping of plasma on the leading portion of the traveling cusp, in sharp contrast to the ineffectiveness of the trailing half of the cusp in retaining and accelerating plasma. These findings support a flux trapping concept that was devised to improve the field-plasma interaction as well as containment and disengagement of the plasma from the traveling field at the end of the transmission line. Also, direct evidence was found for the presence of circulating Hall currents in the accelerator. Additionally, there is strong evidence for the occurrence of a large-scale instability that developed in the reflecting wave. Data displaying the time sequential development of B_z, B_r, B_Θ, and plasma density in the traveling field accelerator are plotted. Application of superconductivity to traveling field devices is also discussed. The system used in the preceding studies had a low overall efficiency and thrust that, however, could be improved. (auth)

16772 (CEA-2213) CONTRIBUTION À L'ÉTUDE DE LA RÉSONANCE NUCLÉAIRE DANS LES CORPS FERROMAGNETIQUES. (Contribution to the Study of Nuclear Magnetic Resonance in Ferromagnets). Claude Robert (France. Commissariat à l'Energie Atomique, Centre d'Etudes Nucléaires, Saclay). 1962. 70p.

Thesis submitted to Université, Paris.

Properties of nuclear magnetic resonance in the field acting on the nucleus in a ferromagnet were studied. Nuclei were Fe^{57} in iron and yttrium iron garnet. Static properties of resonance (frequency, line-width, dipolar structure) were investigated and compared with magnetic behavior and magnetic structure of the materials. Relaxation in garnet points out importance of long range fluctuations induced by impurities in a ferromagnetic lattice. (auth)

16773 (EDR-3207) INVESTIGATION OF THE MONO-CAPILLARY THERMIONIC EMITTER AS A DUAL SOURCE OF IONS AND ELECTRONS. Quarterly Technical Progress Report No. 4, August 15, 1962–February 15, 1963. D. L. Dresser and W. Laurita (General Motors Corp. Allison Div., Indianapolis). Feb. 15, 1963. Contract AF33(616)-8299. 120p.

Theoretical work is reported on a random current model of the capillary emitter—in this model the ion and electron emission currents are dependent upon the atom density at the capillary exit, and the emitter temperature. A solution of the cesium flow through a multicapillary converter was obtained in order to estimate the interelectrode pressure. Experimental data on three multicapillary converters are reviewed. It is shown that the experimental data are in good agreement with the random current theory and flow solution. At the higher cesium temperatures the multicapillary converter has a power density comparable to conventional converters because the interelectrode pressure is not negligible. It was concluded that the capillary in its present form is competitive with, but not superior to, the simpler designs of thermionic converters in the emitter temperature range from 1400 to 1800°K. A modified form of the capillary as a hollow cathode structure with no flow-through of cesium may offer advantages in the temperature range from 1800 to 2200°K. (auth)

16774 (GA-3642) CARBIDE CATHODE STUDIES. PHYSICAL AND CHEMICAL REDEPOSITION. Final Report. L. Yang, A. F. Weinberg, S. Langer, and R. G. Hudson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Jan. 30, 1963. Contract NAS 3-2301. 54p.

A program to explore the possibility of using physical and chemical methods for reducing the vaporization loss of UC–ZrC cathodes in a thermionic cell is discussed. The physical method consists of the proper selection of anode temperature, anode material, and interelectrode spacing such that the condensation of the vapor of the cathode materials on the anode would be reduced or suppressed. Preliminary results obtained by using a UC cathode and a metal anode (Ni- or Pt-plated monel) showed that the anode capture of uranium vaporized from the cathode tended to decrease as the anode temperature increased. The chemical method involves the use of chemical additives to transport the vaporized materials back to the cathode. A glass cell containing a cathode consisting of a guarded Mo anode and of a resistively heated W filament electrophoretically coated with a layer of carbide was used to study the effect of chemical additives on the rate of vaporization of carbides. This effect was determined by comparing the time needed for the removal of the carbide layer by vaporization in vacuum with the time needed for the removal by vaporization in the presence of the chemical additives; electron emission monitoring was used to indicate when the carbide layer was removed by vaporization. (H.G.G.)

16775 (GACD-2813) HIGH-TEMPERATURE BROAD-BAND SEMICONDUCTORS. Quarterly Technical Summary Report, October 1, 1961–December 30, 1961. Melvin Cutler (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Jan. 3, 1961. Contract NObs-77144. 28p. (AD-278406)

Progress on the development of semiconductor materials for the direct conversion of heat to electricity in the temperature range above 800°K is reported. Attempts were made to prepare refractory, rare-earth, p-type semiconductors. In each case weakly p-type material was formed with an electrical resistivity too high for use as thermoelectric materials. A theoretical examination showed that there is a direct relation between the vapor pressure of sulfur in equilibrium with a sulfide compound and the position of the Fermi energy which is of such a nature as to tend to make compounds unstable at high temperatures when the Fermi energy is brought close to the valence band edge, as it must be in preparing strongly p-type materials. Techniques were developed for determining the electron concentration in cerium sulfide samples by means of accurate density measurements in conjunction with the knowledge of the lattice constant. Results suggest that electron conduction is in a band that has a high density of states compared to usual conductors. It was found that cerium sulfide not doped with barium is considerably superior in its thermoelectric properties to what was reported previously. Fairly high figures of merit were obtained at temperatures well below 1000°C. Work was continued on the praseodymium sulfide compounds. (M.C.G.)

16776 (GAMD-2288) SOME FUNDAMENTAL PROPERTIES OF SHOCK WAVES. M. J. Nowak (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 1, 1961. Contract AF29(601)-2207. 10p.

The Rankine-Hugoniot conditions based on steady, one-dimensional flow are shown to be completely satisfactory and to hold for non-steady curved shocks. An examination of the shock jump conditions proves that the internal and kinetic energy of a strong shock are equipartitioned and indicates that the kinetic energy of any shock cannot exceed its internal energy. A similarity solution of the equation for the motion of a strong spherical shock is also derived. (D.C.W.)

16777 (GAMD-3095) NON-STEADY RADIATION TRANSPORT AND THE THICK-THIN APPROXIMATION. M. J. Nowak (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Apr. 12, 1962. Contract AF29 (601)-2207. 12p.

Radiation transport of energy during the motion of hot gases is examined to find means of using opacity data. The work is based on the rate of material heating at any point for a known temperature distribution. An expression for heating rate in terms of the temperature or black body intensity distributions is presented. Approximations based on the heating equation are obtained for optically thick and optically thin problems. The thick-thin approximation is also introduced. Similarly the thick-thin approximation for multi-group rather than one-group treatment is also obtained. The validity of the diffusion approximation is examined, and obtaining a better approximation for multi-group treatment is considered. (D.C.W.)

16778 (GEMP-192) COMPUTER PROGRAMS DESCRIBING COLLISION CASCADES IN BINARY MATERIALS. I. SQUARE PLANAR LATTICE. D. G. Besco and J. R. Beeler, Jr. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Feb. 1963. Contract AT(40-1)-2847. 40p.

An IBM 7090 computer program calculates the results of the bombardment of a square planar lattice of binary material by a single atom of specified type, position, direction, and energy. The hard sphere model is used to compute the results of collisions. The collision radii are based on the Bohr screened coulomb potential. The computer records the entire history of the bombarding particle and all knock-ons, and prints a map of the defect configuration after the collision cascade, showing the location of all vacancies and interstitials. (auth)

16779 (ISS-62/17) NUCLEAR MAGNETIC RESONANCE WITH ULTRASOUNDS IN Si. G. Ascarelli (Italy. Istituto Superiore di Sanità, Rome). Apr. 27, 1962. 29p.

The feasibility of a nuclear spin resonance experiment using ultrasounds is investigated. Efforts are made to observe transitions between spin levels of nuclei that do not have an electric quadrupole moment; they are levels among which an electric field gradient cannot induce transitions. The envisaged transitions should take place through a modulation of the g factor of holes on the top of the valence band of Si. The modulation is produced by the application of a sinusoidally varying strain. It is found that the largest change in the g factor of a hole is obtained when a transverse strain wave propagating in the (100) direction is applied to the sample, the direction of polarization of the elastic wave is the (010) direction, and the magnetic field is in the (110) direction. Under these conditions $1/g\ (dg/d\epsilon)\ d\epsilon \simeq 10^{11}\ d\epsilon$. The calculation can explain the order of magnitude of the nuclear spin relaxation times evaluated or measured by other workers. (auth)

16780 (ISS-62/23) RELAZIONE SULL'ATTIVITA DEI REPARTI 1° e 2° DEI LABORATORI DI FISICA (SOTTOSEZIONE "SANITA" ASSOCIATA ALL'INFN) NEL 1961–1962. (Progress Report of the Sanita Subsection of the INFN During the Period 1961–62). (Italy. Istituto Superiore di Sanita, Rome). June 20, 1962. 25p.

Research at the Sanita subsection of the INFN involving computation of kinematical tables for photoproduction, measurement of Compton effect on bound electrons and fluorescent yield, study of the effect of strong accelerations on weak interactions, measurements of π^0 single photoproduction, measurement of Compton effect protons, study of new neutral meson photoproduction, measurement of neutron spectra following π^- meson absorption at rest, and development and improvement of equipment and procedures for research is summarized. The results were published previously. 28 references. (D.C.W.)

16781 (JINR-P-1159) RAVNOVESNOE RASPREDELENIE RELYATIVISTSKOGO GAZA. (Equilibrium Distribution of Relativistic Gas). N. A. Chernikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 28p.

The equilibrium distribution of a relativistic gas was treated from the point of view of the kinetic equation. It is proved that in the relativistic case the general solution of the functional Boltzmann equation is the relativistic Maxwell–Boltzmann distribution. A general form of the gravitational field in which the global relativistic Maxwell–Boltzmann distribution is possible was found. Maxwell–Boltzmann distribution in the special theory of relativity was investigated. Some examples were considered: the rotating gas, gas in a stationary gravitational field, and some particular cases of the distribution of gas consisting of particles with zero rest mass. (auth)

16782 (JUL-99-PP) TRANSIENT PHENOMENA CONNECTED WITH THE OPERATION OF LARGE LOW INDUCTANCE CAPACITOR BANKS. H. Fay and E. Hintz (Kernforschungsanlage. Institut für Plasmaphysik, Jülich, Germany). Jan. 1963. 28p.

Failure of the sparkgap of one of the units composing a high energy capacitor bank to break down at the proper time can lead to the development of high voltage transients at the units capacitor terminals. Means to prevent these transients, which lead to insulation breakdown, are discussed. Techniques for avoiding uncontrolled operation of the main bank by the discharge of an auxiliary bank connected to it by a common load are also discussed. (D.C.W.)

16783 (LADC-5128) THERMIONIC EMISSION CHARACTERISTICS OF CERTAIN ACTINIDE COMPOUNDS. F. P. Cranston, Jr. and J. W. Barger (Los Alamos Scientific Lab., N. Mex.). [1960]. Contract W-7405-eng-36. 17p.

Thermionic emission constants of UC, $UMoC_2$, Pu_2O_3, Pu_2O_3 + PuC, UWC_2, and Np_2C_3 were measured. A cylindrical diode geometry was used. The emitter consisted of a 0.030-in. W wire coated electrophoretically with the desired substance. (auth)

16784 (NASA-TR-R-161) THEORETICAL AND EXPERIMENTAL STUDY OF THE INTERACTION OF FREE-SURFACE WAVES ON LIQUID METALS WITH TRANSVERSE MAGNETIC FIELDS (ONE-DIMENSIONAL UNSTEADY WAVES). Vernon J. Rossow (National Aeronautics and Space Administration. Ames Research Center, Moffett Field, Calif.). 1963. 112p.

The free-surface analogy that exists between pressure waves in an ionized gas and waves on the surface of a liquid metal is studied experimentally and theoretically by considering in detail the interaction of one-dimensional waves in a channel with a transverse magnetic field. Photographic sequences are presented of the surface shapes found experimentally with mercury and the eutectic alloy of sodium and potassium (NaK). These results are compared with the corresponding surface profiles predicted theoretically by the one-dimensional mathematical method of characteristics for unsteady flows. The analogy is to be a useful tool for studying certain aspects of magnetohydrodynamic flow fields. The tests carried out in the investigation also provide information on the interaction of one-dimensional waves with a transverse magnetic field. 36 references. (auth)

16785 (NYO-3062) ELECTRON PARAMAGNETIC RESONANCE IN SOME MOLECULAR TRANSFER COMPLEXES. Dennis H. Stamires and John Turkevich (Princeton Univ., N. J.). Feb. 20, 1963. Contract AT(30-1)-1158. 41p.

Electron paramagnetic resonance studies were carried out on several new electron transfer molecular complexes in solid and liquid state. A paramagnetic complex is formed when triphenylamine, a strong donor, interacts with acceptors such as iodine, trinitrobenzene or tetracyanoethylene. The system triphenylamine (ϕ_3N)-iodine was studied in more detail. Both in solid and liquid state the donor positive ion radical of ϕ_3N was identified by the characteristic hyperfine structure due to the interaction of the paramagnetic electron with the nucleus of N^{14}. Further, the state of the $[\phi_3N\cdot]^+$ in solution, molten or solid state was ascertained through changes in the hyperfine

structure. The EPR adsorption of the $[\phi_3N\cdot]^+ [I_2]^-$ complex in solid state was found to increase with increasing temperature. The results can be described in general by a Curie-Weiss law behavior, indicating the state of spins to be a ground singlet paramagnetic state with a g value of 2.0025 ± 0.0002. The relaxation parameters T_1 and T_2 were found to be 1.8×10^{-9} and 1.6×10^{-8} sec respectively at room temperature. In solutions of these complexes where the paramagnetic electrons were identified through hyperfine structure, characteristic U.V. absorption bands were found. These bands can now be ascribed to electron-transfer transitions. (auth)

16786 (NYO-10250) PRINCIPLES OF CLASSICAL DYNAMICS. N. Mukunda, ed. (Rochester, N. Y. Univ.). Jan. 23, 1963. Contract AT(30-1)-875. 247p.

Mathematical formulations applicable to phenomena of classical dynamics are examined starting from simple Newtonian mechanics and passing through hamiltonian and Lagrangian systems to relativistic considerations. The associated algebra is introduced in the course of the development. (D.C.W.)

16787 (PWA-2163) DETERMINATION OF THE EMISSIVITY OF MATERIALS. Quarterly Progress Report, October 1 through December 31, 1962. R. J. Hayes (Pratt and Whitney Aircraft Div., United Aircraft Corp., Hartford, Conn.). Contract NASw-104. 95p.

An aluminum phosphate bonded mixture of nickel–chrome spinel and silicon dioxide completed 10,720 hours of endurance testing on a SNAP-8 finned-tube radiator segment. Flame-sprayed coatings of titania on SNAP-8 and Sunflower I sections completed 9870 and 9830 hours, respectively. A fourth rig containing a SNAP-8 section with an aluminum phosphate-bonded mixture of silicon carbide and silicon dioxide completed 8600 hours of testing. Emittance measurements are reported on fifteen materials. These fifteen materials are stannic oxide, silicon dioxide, palladium black, nickel oxide, chromic oxide, cobalt oxide, boron carbide, iron–titanium–oxide, iron–titanium–aluminum oxide, oxidized kennametal K-151-A, titania, calcium titanate, strontium titanate, silicon carbide, and manganese oxide. All coatings were bonded to niobium–1% zirconium substrates except palladium black and oxidized kennametal K-151-A which were bonded to AISI-310 stainless steel. Two grades of titania were tested to determine the effects of purity on emittance. The total hemispherical emittance of all materials were measured over a range of temperatures. In addition, the spectral normal emittances of boron carbide, iron–titanium–oxide, the higher purity titania, and silicon carbide were measured. Iron–titanium–aluminum oxide, strontium titanate, and silicon carbide were subjected to short term endurance testing. The total hemispherical emittance of strontium titanate was measured in all three emittance rigs for comparison purposes. (auth)

16788 (R58AGT967) MAGNETOHYDRODYNAMICS. B. Podolsky (General Electric Co. Aircraft Gas Turbine Div., Evendale, Ohio). Nov. 1958. 21p.

Magnetohydrodynamic (MHD) equations of continuity, energy, and motion are derived. Additionally, an expression is obtained for the rate at which viscous forces impart energy to the material within a surface in the fluid. MHD expressions are also presented for F, the combination of electromagnetic and gravitational force per unit volume, and for the heat energy generated per unit volume per unit of time. Forms of the equation of state are discussed, and examples involving an ideal gas, incompressible fluid flow, and isothermal flow are examined. Maxwell's equations and associated expressions for electric displacement, magnetic induction, and Ohm's law are also discussed. Electrodynamic and hydrodynamic conditions that appear at MHD surfaces of discontinuity are also briefly examined. (D.C.W.)

16789 (TID-18145) THE ROLE OF COMPUTERS IN EXPERIMENTAL PHYSICS: A SYSTEM FOR ON-LINE ANALYZERS. W. F. Miller (Argonne National Lab., Ill.). Dec. 1962. Contract [W-31-109-eng-38]. 13p. (UAC-7096)

The role of computers in data handling for experimental physics is briefly reviewed. Steps in a long range plan drawn up for the automation of an experimental laboratory are given, and the status of realization of each step is summarized. Operation of the film data analyzer CHLOE, particularly its time sharing and the computer handling it, is also discussed. (D.C.W.)

16790 (TID-18216) FIELD REVERSAL IN TENUOUS PLASMA: EQUIPMENT STATUS REPORT. W. Pak, K. C. Rogers, H. Huber, J. R. M. Coulter, and G. Schmidt (Stevens Inst. of Tech., Hoboken, N. J.). [1962]. Contract AT(30-1)-2813. 23p. (SIT-P85(2/63))

Components of the d-c system for producing the cesium plasma column are described, particularly the electrodes and the cesium source. Measurement of the magnetic field with a Hall effect probes is explained as in the calibration of the plate temperature. Preliminary measurements of plasma density with a Langmuir probe yielded values of about 10^{11} cm^{-3}. The single turn field coil, the capacitor bank, and the switches of the a-c system to be used in applying the reverse field are described. (D.C.W.)

16791 (TID-18231) THE SPECTRUM, THE EXCITATION AND IONIZATION CROSS-SECTIONS FOR PHOTO PROCESSES AND FOR COLLISIONS, OF FIVE TIMES IONIZED OXYGEN. Quarterly Report No. 7, December 1, 1962–February 28, 1963. Carlos M. Varsavsky (P.E.C. Corp., Boulder, Colo.). Contract AT(11-1)-1017. 30p.

Errors noted in a previous work on using the screening method to calculate photoionization cross sections were corrected. An integral that can be used to obtain the value of the photoionization cross section at the spectral head more easily than by the previous method was derived and evaluated for eleven cases. Values were obtained for the ionization of several electrons (s, 2p, etc.) and are graphed. The applicability of the method for various transitions was also examined. The simpler of two previously reported screening methods was used to obtain the photoionization cross sections for the seven lowest levels of O VI. The available atomic data (primarily theoretical) for O VI were surveyed. Several methods for calculating the positions of energy states were examined, and the results obtained with each were compared to experimental values and to values obtained with the other methods. Theoretical calculation of the O VI levels with a high accuracy was deemed possible. Similarly, techniques for obtaining wave functions for the states involved in transitions were surveyed and compared; fairly accurate wave functions can apparently be obtained for all O VI levels. Comparison of the Coulomb approximation and the screening theory for bound-bound transitions reveals good agreement. Accurate values are found readily available for treating such transitions. Calculation of photoionization cross sections for bound-free transitions by the screening method and by the quantum defect method gave comparable values, except for ionization from 3s and 4s

states where the screening method gave results twice as large. (D.C.W.)

16792 (TID-18258) THE IONIZATION OF ALKALI IONS BY ELECTRON IMPACT. Quarterly Technical Progress Report No. 1, December 1, 1962–February 28, 1963. J. W. Hooper, E. W. McDaniel, and W. C. Lineberger (Georgia Inst. of Tech., Atlanta. School of Electrical Engineering). Mar. 1, 1963. Contract AT(40-1)-3027. 6p.

Work on the project to measure the cross section for ionization of Li^+ ions by electron impacts for beam energies from 75.6 to 1000 ev consisted mainly of design and construction of the apparatus and facilities. A noninterrupting method for measuring charged particle beam currents was developed. The technique embodies passage of the pulsed beam through a mu-metal toroid on which is wound a coil. Beam current magnitude and wave shape are read from the voltage in the coil. (D.C.W.)

16793 (TID-18265) STUDIES OF H_2^+ DISSOCIATION. PHASE III. Quarterly Progress Report No. 1, November 15, 1962–February 15, 1963. A. W. Ehler (Hughes Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). Feb. 28, 1963. Contract AT(04-3)-362. 4p.

The experimental system for measuring the dissociation of H_2^+ ions injected into an electric field was studied to ascertain that the dissociation ratio measured actually resulted from the effect of the electric field. Dissociation ratios for several field strengths were measured; the results agree well with previous results and have a smaller standard deviation. Essentially constant ratios of 3.5×10^{-3} between 0.6×10^5 and 1.6×10^5 v/cm and of 4.7×10^{-3} between 4.2×10^5 and 5.5×10^5 v/cm indicate a step dependence of ratio on field strength. Variation of the electric field strength was obtained by sliding sleeves of various thicknesses over the rod placed concentrically within the dissociation chamber. Dissociation ratios measured with the sleeves in place were the same as for the rod itself. (auth)

16794 (UCRL-10523) ARGON–HELIUM SCINTILLATION. Theodore Jenkins and Roger Wallace (California. Univ., Berkeley. Lawrence Radiation Lab.). Oct. 24, 1962. Contract W-7405-eng-48. 34p.

The scintillation of liquid argon and gaseous helium was investigated. Precise temperature control and care in purification were required. Alpha and gamma sources were used. A variety of mixture ratios of argon and helium were tried. The scintillators were found to be insensitive to gamma rays relative to alphas. Scintillations were not detected in liquid argon but only in the gas. Neutron 4π spectroscopy with these scintillating gasses is discussed. (auth)

16795 (AEC-tr-5575) RESEARCH IN ELECTRON THEORY OF CRYSTALS. S. I. Pekar. Translation of "Issledovaniya po Elektronnoi Teorii Kristallov" (a publication of the State Publishing House of Technical and Theoretical Literature, Moscow, 1951). 240p.

Polaron theory and the theory of local states of electrons in dielectrics and semiconductors are derived. Polaron theory treating the motion of conduction electrons quantum mechanically and the motion of ions both classically and quantum mechanically is explored. The mathematical formalism developed in handling conduction electrons is then extended for an examination of local states of electrons in F and F′ centers, once again treating ion motion both classically and quantum mechanically. Calculations applying the theory to specific crystals agree well with experimental results. (D.C.W.)

16796 (AEC-tr-5695) PRODUCTION OF STRONG MOLECULAR BEAMS IN HIGH VACUA BY MEANS OF JETS. Gerhard Becker. Translated from Z. Angew. Phys., 13: No. 2, 59-64(1961). 15p.

Measurements were made of the intensities of molecular beams of ammonia provided by jet-type collimators of various sizes and by slot collimators for flow rates n_C in the range 10^{15} to 4×10^{18} mol/sec. The collimation gain χ_{eff} was compared with that given by a simple aperture. The χ_{eff} for the jet type collimators was ~3 for flow rates of 10^{18} mol/sec, those for slot collimators being 1.5. The effective channel length l_{eff} is introduced to interpret this behavior. Results show that the highest possible degree of collimation for a collimator with channels of an l_{eff} much less than the geometrical length is not obtained by dividing a given total area into as many channels as possible but by dividing it into slots. (H.G.G.)

16797 (UCRL-Trans-907(L)) THEORY OF THE PHOTOELECTRON EMISSION BY METALS. I. CALCULATION OF THE EXTERNAL ENERGY ANGULAR DISTRIBUTION. II. DISTRIBUTIONS OF THE PHOTOELECTRONS. Heinz Puff. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore) from Phys. Status Solidi, 1: 636-49; 704-15(1961). 39p.

A theory of the volume photoelectric effect for alkali metals is developed in the free-electron approximation taking into account the transport of the excited electrons. The results are used in calculating the spectral distribution, the energy distribution, and the angular energy distribution of the normal and of the selective volume photoelectric effect for the special case of potassium. The results are, when possible, compared with experimental data. The theory does not explain the details of the energy distribution. The calculated angular distributions can not be discussed due to the lack of experimental knowledge. 27 references. (auth)

16798 "UNIFORMLY ACCELERATED" MOTION AND RELATIVITY. L. Infeld (Univ. of Warsaw). Acta Phys. Polon., 23: 69-75(Jan. 1963). (In English)

In an appropriate de Sitter universe a transformation exists representing a transition from rest to a "uniformly accelerated" motion that does not change the quadratic line element of this universe. This transformation is particularly simple in the coordinate system $\xi = t + t_{(0)} + x/c$, $\eta = t + t_{(0)} - x/c$. It reduced to $\xi' = t_{(0)}^2/\eta$, $\eta' = t_{(0)}^2/\xi$, where $t_{(0)}$ is an arbitrary constant. (auth)

16799 STATISTICAL AND THERMODYNAMICAL DESCRIPTION OF CORRELATED SYSTEM. I. GENERAL CONSIDERATIONS. Andrzej Fuliński (Jagellonian Univ., Krakow). Acta Phys. Polon., 23: 93-9(Jan. 1963). (In English)

The general definitions, master equations, statistical correlation functions, and formulas for observables and their time changes, in general form, were given for two interacting subsystems weakly, strongly, or completely correlated. (auth)

16800 CHARACTERISTICS OF A HIGH FREQUENCY ION SOURCE IN THE IONIZATION OF HYDROGEN AND HELIUM. Armas Fontell (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A VI, No. 119, 1-23(1963). (In English)

The properties of a conventional high frequency ion source with inductive power coupling were investigated with an experimental arrangement for focusing and analyzing an ion beam of about 1 ma extracted from an ion source. In the cathode canal of the ion source a diaphragm was used, which, when properly positioned, reduced the gas con-

sumption to about one-third without lowering the ion current. The resonance-like effect of a static magnetic field on the gas discharge was observed as an increase of the ion current. The resonances produced by transverse and longitudinal magnetic fields were compared with each other by studying the dependence of the ion current on the gas pressure at the magnetic induction values which caused resonances to occur. The ion beams obtained with hydrogen and helium discharges were analyzed with this equipment. On the basis of the dependence on hydrogen pressure of the number of H_2^+ ions in the discharges in hydrogen and hydrogen-helium mixture, an upper limit on the current of He^{2+} ions in the helium spectrum could be estimated to be $He^{2+}/He^{+} < 0.3\%$. It was found by theoretical considerations that by using 70,000°K as the typical electron temperature characterizing the hydrogen discharge and an ion density of 5×10^{10} cm^{-3} values consistent with actual conditions are obtained for the ion current and for the average lifetime of the plasma electrons. One method of calculating the average lifetime is based on the known ionization cross sections and on the assumed validity of the Maxwell-Boltzmann energy distribution law. The number of He^{2+} ions formed in the helium discharge was also estimated theoretically, and it was found that the majority of such ions is generated from helium atoms in one collision. At an electron temperature corresponding to 40 ev the theoretical number of He^{2+} ions still remains below the experimentally determined upper limit. (auth)

16801 STUDY OF PLUTONIUM BY HIGH RESOLUTION SPECTROSCOPY. I. CONTRIBUTION TO THE CLASSIFICATION OF THE ARC SPECTRUM. Simon Gerstenkorn (Centre National de la Recherche Scientifique, Paris). Ann. Phys. (Paris) (13), 7: 367-404(July-Aug. 1962). (In French)

The experimental study of the arc spectrum of Pu was preceded by a theoretical review of the methods used for the classification of complex spectra and their application to the classification of the arc spectrum of Pu. The determination of the J values by measurement of the intensities of the hyperfine components of Pu^{239} and the advantages of this method are reviewed. The experimental study of the hyperfine structure and the isotopic displacement of the rays of the Pu arc spectrum confirmed the ground configuration of neutral Pu $5f^6 7s^2$ while making more precise the structure of the ground multiplet $^7F_{0-6}$. The configuration f^5ds^2 was shown and the first level of this configuration was located. Continued efforts were made to classify the Pu arc spectrum, but the first multiplet of the $5f^6 7s 8s$ is still unknown. The results obtained are shown in tabular form. (J.S.R.)

16802 EXPERIMENTAL INVESTIGATIONS IN THE AREA OF THE SUB-NORMAL LOW PRESSURE GLOW DISCHARGE. G. Hinzpeter (Institut für Gasentladungsphysik, Deutschen Akademie der Wissenschaften, Berlin). Ann. Physik (7), 10: 86-101(1962). (In German)

In the low-current area of the glow discharge, the subnormal discharge, investigations were carried out in a series of gases, especially nitrogen and neon, for the clarification of the behavior of the discharge. Photographs show, at decreasing discharge currents, a preliminary increase of the positive column up to union with the negative glow light, connected with a considerable operating voltage increase on occasion. In addition to the determination of the range of existence, the gradient and the electron temperature which increases to its doubled value were measured. An investigation of the wall current showed at low electron relative high wall loss. It is assumed that the processes in the sub-normal range can be explained by charge carrier deficiency. (tr-auth)

16803 THEORY OF SECOND ORDER ISOTOPE SHIFT. N. J. Ionesco-Pallas (Inst. of Atomic Physics, Bucharest). Ann. Physik (7), 10: 121-40(1962). (In English)

A method of successive approximations in the theory of isotope shifts, consisting in a series expansion with respect to charge powers of the effective nuclear radius of interaction, is applied. The second-order contributions proved to be sufficiently weak. More important seemed to be the effects yielded by the shape of the proton distribution. In addition, the possible effect of triaxiality is considered. A reformulation of hydrodynamic corrections showed that surface energy gives no contribution and the symmetry energy brings an almost negligible contribution, as a result of the statistical variational model for the nucleus. The interpretation of the existing empirical data in terms of the theory led to a satisfactory agreement. (auth)

16804 MEASUREMENT OF THE RADIAL FIELD DISTRIBUTION IN A PENNING DISCHARGE BY MEANS OF THE STARK EFFECT. W. Knauer and M. A. Lutz (Hughes Research Labs., Malibu, Calif.). Appl. Phys. Letters, 2: 109-11(Mar. 15, 1963).

Evidence that the electron current to the anode in a Penning discharge is caused by space-charge limited, classical cross-field mobility was obtained by measuring the Stark effect radially across the discharge. Close agreement between the values of measured current density and the anode current density calculated from electron densities derived from line splitting analysis was observed. (D.C.W.)

16805 NATURE OF THE DRIVING FORCE IN FLUX CREEP PHENOMENA. J. Friedel, P. G. De Gennes, and J. Matricon (Faculté des Sciences, Orsay, France). Appl. Phys. Letters, 2: 119-21(Mar. 15, 1963).

A more accurate expression for the driving force acting on Abrikosov vortex lines in hard superconductors is derived and used to calculate critical currents in Nb_3Sn containing cavities. (D.C.W.)

16806 ON QUANTUM FIELD THEORY METHODS IN THE THEORY OF THERMAL PROPERTIES OF METALS. Clas Blomberg (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 23: 97-116(1963). (In English)

By means of functional variational principles, earlier introduced into the quantum field theory by Schwinger, in the many-body problem of metals a formal expression for the partition function is obtained. This expression is exact in the lowest order of temperature and gives all thermodynamic quantities as functions of the temperature and coefficients, which are to be determined from the ground state. (auth)

16807 THE $1s2s^1S$ LEVEL OF Li^+. Y. G. Toresson and B. Edlén (Univ. of Lund, Sweden). Arkiv Fysik, 23: 117-18(1963). (In English)

The transition $1s2s^1S - 1s2p^1P$ of Li^+ was observed at 9581.42 Å. Combined with $1s2p^1P$ from Herzberg and Moore this gives 118 704.82 ± 0.15 cm^{-1} for the ionization energy of $1s2s^1S$ in complete agreement with the theoretical value 118 704.88 recently reported by Pekeris. (auth)

16808 THE SPECTRUM OF THE NEUTRAL BERYLLIUM ATOM. Lennart Johansson (Univ. of Lund, Sweden). Arkiv Fysik, 23: 119-28(1963). (In English)

The spectrum of neutral beryllium was investigated between 18200 Å and 2050 Å with a hollow-cathode discharge. Furthermore, three vacuum-ultraviolet lines were measured on an arc spectrogram. Wavelengths of about

120 lines were measured. The term system was revised and some new terms added. The ionization limit was determined to 75,192.07 cm^{-1} by means of a Ritz formula for the $2snf\,^1F$ series. (auth)

16809 THE PHOTO ELECTRON METHOD OF DETERMINING h/e. Stig Hagstroem, Olle Hoernfeldt, Carl Nordling, and Kai Siegbahn. Arkiv Fysik, 23: 145-53 (1963). (In English)

A new method was applied for the determination of the fundamental constant combination h/e. Photoelectrons from the same shell in a converter material are expelled by the characteristic x radiation ($K\alpha_1$) from two different elements. The electron lines are brought to a common focus in a high precision iron-free beta-spectrometer by accelerating or retarding the photo electrons. Equating the total applied voltage times the electronic charge, ve, to the energy difference between the two x ray lines, $h(\nu_1 - \nu_2)$, gives h/e. Some preliminary measurements are reported together with a study of possible systematic errors. The measurements give for the quantum energy conversion constant ($E\lambda_s$), (12372.9 ± 1.5)kv • Xu from which (4.1356 ± 0.0006) × 10^{-15} J/A is obtained for the ratio h/e. (auth)

16810 AUGER SPECTRA IN THE INTERMEDIATE COUPLING REGION. Olle Hoernfeldt, Anders Fahlman, and Carl Nordling (Univ. of Uppsala). Arkiv Fysik, 23: 155-63(1963). (In English)

K-LL Auger spectra of the elements from strontium (Z = 38) to silver (Z = 47) were studied with a high-resolution β spectrometer. The nine-line spectrum predicted in the intermediate coupling theory was established in strontium, zirconium, and molybdenum. Energies and relative intensities were measured. From the observed separations of the lines in the strontium, zirconium, and molybdenum spectra, a set of constants is obtained for the calculation of K-LL Auger energies in the intermediate coupling region. These constants differ considerably from those given by Asaad and Burhop, which indicates that for a given set of constants, the corresponding expressions for the calculation of Auger energies are valid only over a restricted Z region. (auth)

16811 A SIMPLE ARRANGEMENT FOR MEASURING THE MOSAIC SPREAD WIDTH OF CRYSTALS. H. A. Neumann and O. W. B. Schult (Technische Hochschule, Munich). Atomkernenergie, 8: 61-2(Feb. 1963). (In German)

Three methods are pointed out in order to measure the reflexion curve for the determination of the width of the mosaic-spread of crystals. A double-crystal spectrometer, giving a very good luminosity, is described. (auth)

16812 IONIZATION OF A GAS BY RADIATION FROM A DISCHARGE. Gaylord W. Penney and Roy E. Voshall (Carnegie Inst. of Tech., Pittsburgh). Commun. Electron., No. 64, 398-403(Jan. 1963).

Measurements of ionization of a gas by radiation from the positive column of a glow discharge indicated that ionizing radiation is produced primarily by collision processes rather than by recombination. The ratio of ions produced by radiation to ions produced in the discharge is plotted as a function of distance from the discharge for oxygen, nitrogen, and air. Application of these data to the initiation of positive corona can account for the observed corona starting voltage. (auth)

16813 EXCITATION OF A DELAYED FLUORESCENCE BY PHOTONS WITH ENERGY LOWER THAN THAT OF THE PHOTONS EMITTED. Bernard Muel (Institut du Radium, Paris). Compt. Rend., 255: 3149-51(Dec. 5, 1962). (In French)

The delayed fluorescence of 3,4-benzopyrene, in solid solution, can be excited in the presence of a dye by photons with energy less than that of the photons emitted. Two molecules of 3,4-benzopyrene, excited in their first excited triplet by energy transfer, interact to carry one of the two molecules to the first singlet state. (tr-auth)

16814 M ABSORPTION SPECTRUM OF PLUTONIUM. Yvette Cauchois, Christiane Bonnelle, and Louis de Bersuder. Compt. Rend., 256: 112-14(Jan. 2, 1963). (In French)

The studies undertaken on the x spectra of transuranic elements were extended to the M absorption spectrum, thanks to a specially developed apparatus which contains a spectrograph with focussing under helium. The five discontinuities of metallic plutonium were measured. (tr-auth)

16815 NEW METHOD PROPOSED FOR THE STUDY OF MULTIPLE SCATTERING BY MEANS OF SECOND DIFFERENCE SUMS OF THE DEFLECTIONS MEASURED ON TRAJECTORIES IN NUCLEAR EMULSIONS. Tsai-Chü, Jeannine Fitan, and Denise Schune-Boisble (Faculté des Sciences, Paris). Compt. rend., 256: 396-8(Jan. 7, 1963). (In French)

The method of the sums of two second differences has the advantage of increasing the multiple scattering and of reducing the background. (tr-auth)

16816 STUDY OF THE TRANSIENT EFFECT ON A SUPERCONDUCTING SPHERE UNDER THE INFLUENCE OF A VARYING MAGNETIC FIELD. Gunadhar Paria (Indian Inst. of Tech., Kharagpur). Indian J. Pure Appl. Phys., 1: 87-90(1963).

The classical problem of the penetration of a magnetic field into a superconducting sphere was investigated for the case when the magnetic field is applied suddenly at a great distance from the sphere. The transient effect was found to be exponential in character. Quantitative evaluation of the depth and time of penetration of the applied magnetic field was also made. (auth)

16817 THE CATHODE SPUTTERING OF MICA AND FUSED QUARTZ BY KRYPTON IONS. A. I. Akishin, S. S. Vasil'ev, and L. N. Isaev. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1356-8(Nov. 1962). (In Russian)

A Kr^{84} ion beam having an energy of 4 to 30 kev was separated out from a small electromagnetic separator, and was used to determine the cathode sputtering coefficient for mica, quartz, and glass. The current was 10μA cm^{-2} for mica, and 100 to 200μA cm^{-2} for quartz and glass. The number of ions striking the target was determined indirectly by measuring the electron emission current from a thermoelectron cathode placed above the target. These measurements were accurate to ±10%, as confirmed by direct measurement of the ion current with a Faraday cage. The difference in the weight of the target before and after bombardment was determined by weighing on a microbalance. The loss in weight was 1 to 2 mg for an average irradiation dose of 300μA-hrs. The operating pressure was 3×10^{-4} mm Hg std. The sputtering coefficient rose to about 130 to 140 atomic mass units per krypton ion at an energy of 10 kev, and leveled out at this value up to an energy of 30 kev. (TTT)

16818 THE BREAKDOWN OF METALS BY ION BEAMS AS A FUNCTION OF THE ANGLE OF INCIDENCE. V. A. Molchanov and V. G. Tel'kovskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 26: 1359-65(Nov. 1962). (In Russian)

The breakdown of a metal surface by an ion beam as a

function of the grazing angle was studied because of the importance of this problem in high-temperature plasma physics and in ion rockets. A large double-focusing mass-spectrometer with a sectered magnetic field was used to obtain monoenergetic ion beams. It was found that the sputtering of copper with 25 kev argon ions increases with increasing time of irradiation. The pressure was 2×10^{-7} mm Hg std, and special pains were taken to eliminate contaminants. It was found that on polycrystalline material, the sputtering coefficient increases with increasing angle of incidence of the ions on the target, and is inversely proportional to the cosine of the angle of incidence. On irradiating monocrystalline samples with an ion beam, the sputtering coefficient dropped off sharply, as the direction of the ion beam approached the direction of the principal crystallographic axes of the sample. The angular distribution of the sputtered particles was determined by collecting the particles on a spherical catcher surrounding the target. The distribution of collected matter near a crystallographic axis is described by a Gaussian curve having a half-width of 20°. The irradiation of monocrystals by ions of different mass and energy showed that the distribution of particles near the crystallographic axes does not depend on the mass and energy of the bombarding ions. Irradiation doses of 2 to 3mA-hr-cm^{-2} did not result in a broadening of the angular distribution of sputtered particles of 18 to 20°. Displaced lattice atoms were found to play a significant role in radiation damage to metals. (28 references.) (TTT)

16819 PARAMAGNETIC RESONANCE OF 3+ DILUTED Gd^{3+} IN Pd IN THE PRESENCE OF RARE EARTH IMPURITIES. M. Peter (Bell Telephone Labs., Murray Hill, N. J.). J. Phys. Radium, 23: 730-2(Oct. 1962). (In French)

The conduction electron polarization around localized magnetic impurities was investigated in Pd by means of a study of the paramagnetic resonance spectrum of dilute Gd in Pd. The sign of the average of the polarization is negative in the case of the rare earths. The basic interaction is therefore not the atomic exchange interaction. The range of the polarization is unusually long in the case of the Pd alloys. It is pointed out that the anisotropic polarization calculated by Gauthier on the basis of Fletcher's band structure for Ni, would in part explain this long range, and that Wolff's calculation, which includes the electron-electron interaction would further enhance the range. Susceptibility data on the dilute alloys are discussed. (auth)

16820 NUCLEAR MAGNETIC RESONANCE IN CHROMIUM–VANADIUM ALLOYS. L. E. Drain (Atomic Energy Research Establishment, Harwell, Berks, Eng.). J. Phys. Radium, 23: 745-9(Oct. 1962). (In English)

Observations were made of the V^{51} magnetic resonance shift and line width in chromium–vanadium solid solutions over a wide composition range. The Knight shift varies considerably with composition reaching a maximum value of 0.687% for an alloy containing 62% chromium. This may be connected with the appearance of magnetic moments on the Cr atoms. A slight dependence of shift on magnetic field is found and is attributed to second order quadrupole effects. The line width decreases to a value of about 1.5 gauss as the concentration of chromium increases due to the reduction dipolar broadening. A discussion of the field dependence of the line width is given. For vanadium concentrations less than 5% broad transitions appear at which the intensity of the resonance signal decreases. This is attributed to the appearance of antiferromagnetism. (auth)

16821 ACTION OF A UNIFORM FORCE FIELD ON A GAS. TRANSITORY REGIME. ISOTOPIC SEPARATION. Alexandre Pozwolski. J. Phys. Radium, 23: 898-900(Nov. 1962). (In French)

A gas with a Maxwellian distribution of velocity is first considered in equilibrium with constant concentration. In a uniform field of force—such as the gravitational field—this gas gets a new equilibrium state, described by the Boltzmann equation, and the concentration of particles with distance is a function of their mass, so separation of isotopes is observed. The law of variation of concentration with time during the transient state between the two states of equilibrium under survey is shown. (auth)

16822 STATISTICAL MECHANICS OF TRANSPORT PHENOMENA IN GASES AT MODERATE DENSITIES. Syu Ono (Tokyo Univ.) and Toshio Shizume. J. Phys. Soc. Japan, 18: 29-54(Jan. 1963). (In English)

A general method to expand the transport coefficients of dense gases in powers of the number density is developed, on the basis of the statistical mechanics of irreversible processes. The Ursell-Mayer expansion method is applied to the Liouville operator with use of the perturbation method which is reformulated for classical mechanics in this paper. This expansion method enables us to obtain the transport coefficients in the form of power series in the density. The exponential decay of the correlation functions of fluxes is obtained from the theory. The second approximation to the viscosity coefficient is obtained in the form which is useful for the numerical calculation. (auth)

16823 EXTENDED METHOD OF THE CALCULATION IN THE CASE OF ATOMS WITH 1s- AND 2p-ELECTRONS. K. K. Eringis, Ya. I. Vizbaraite, and A. P. Yutsis. Lietuvos Fiz. Rinkinys, 1: 291-7(1961). (In Russian)

The extended method of calculation of atomic structures is applied to the normal configuration of helium-like structures and to the configurations $1s^22p^2$ and $1s^22p^3$ of the Be-like and B-like structures with the aid of analytic wave functions. By the "extension of the method of calculation of atomic structures" is understood the use of the same number of radial wave functions as there are electrons in the atom. (auth)

16824 THE ANALYTIC AND BOUNDEDNESS PROPERTIES OF A THREE POINT FUNCTION IN A QUANTUM ELECTRODYNAMIC LIKE MODEL. Roland Gudmundsson (Univ. of Lund, Sweden). Nucl. Phys., 40: 202-45(Jan. 1963). (In English)

The vacuum expectation value of three currents $j_k(\chi) = g\phi_l(\chi)\phi_m(\chi)$ is studied in the second non-vanishing approximation of perturbation theory. The fields $\phi_k(\chi)$ are scalar fields and have an interaction constructed in analogy with quantum electrodynamics. The analytic and boundedness properties of contributions, illustrated by twelve different Feynman diagrams, are investigated. It is shown that all contributions are analytic in the product of the three cut planes. However, three of the diagrams give contributions that increase exponentially in certain directions outside the holomorphy envelope for the three-point function. Therefore, these diagrams cannot be written as a superposition of products of Δ_F functions. They must be represented by means of some more general formula as, e.g., by the Bergman-Weil integral for the threepoint function. (auth)

16825 A METHOD OF REGULARIZATION IN FIELD THEORY. M. A. Markov (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 40: 309-20(Jan. 1963). (In English)

Functions transforming into plane waves at $t \to \pm\infty$ are used instead of plane waves for the construction of the

S-matrix. The free-field quantum acquires the meaning of a particle only at $t \to \pm\infty$. The formalism is constructed in this way: a certain "counterfield" $\varphi'(\chi)$, damping in time, is added to the usual free field $\varphi^0(\chi)$. This counterfield, quantized according to indefinite metrics (with the reverse sign), regularizes the Δ^0-functions. The quanta of $\varphi'(\chi)$ disappear at $t \to \pm\infty$. The counterfield makes no contribution to the probabilities and cross sections for the observed effects. The theory is causal, unitary, and relativistically invariant. (auth)

16826 ON QUANTIZATION OF FIELDS. L. Rosenfeld (NORDITA, Copenhagen). Nucl. Phys., 40: 353-6(Jan. 1963). (In English)

Critical remarks are presented on some formal and physical aspects of field quantization, with special application to the case of gravitation. (auth)

16827 EVOLUTION OF EQUILIBRIUM IN IONIZED GASES. B. Bertotti (Laboratorio Gas Ionizzati, Frascati, Italy). Nuovo Cimento (10), 25: Suppl. No. 2, 100-7(1962). (In Italian)

The approach toward thermal equilibrium of an ionized gas and the transport phenomenon connected with it are only slightly known because of the theoretical and experimental complexities of the problem. A brief discussion is presented of this problem with emphasis on the principal concepts and the unanswered questions. (J.S.R.)

16828 A NOTE ON LOCAL COMMUTATIVITY. Y. Tomozawa (Istituto Nazionale di Fisica Nucleare, Pisa, Italy). Nuovo Cimento (10), 27: 543-9(Jan. 16, 1963). (In English)

A theorem on local commutativity in quantum field theory is proved. (C.E.S.)

16829 RELATIVISTIC VIRIAL THEOREM. N. N. Rosenbluth and G. W. Stuart (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 6: 452-3(Mar. 1963).

The denial of plasmoid existence — a plasmoid being a self-confined bundle of electromagnetic and material energy — is extended to relativistic systems. (C.E.S.)

16830 SUPERCONDUCTIVITY IN "NORMAL" METALS. P. G. De Gennes and E. Guyon (Faculté des Sciences, Orsay, France). Phys. Letters, 3: 168-9(Jan. 1, 1963). (In English)

The superconducting transition temperature (T) of a film of a given metal, which is in contact with a superconducting film, is discussed. The given metal is assumed to exhibit no superconductivity in the bulk state. It is shown that an analysis of the dependence of T on the thickness of the normal-metal film can be used to evaluate one of the superconducting parameters (in the Bardeen-Cooper-Schrieffer model) of the given metal. (T.F.H.)

16831 A NOTE ON GRAVITATIONAL INSTABILITY. R. L. Liboff (New York Univ., New York). Phys. Letters, 3: 322-3(Feb. 15, 1963). (In English)

The stability of an infinite system of mass points interacting under a Newtonian force is examined through a microscopic analysis. (C.E.S.)

16832 GRAVITATIONAL ENERGY RADIATION. C. Moeller (Universitetets Institut for Teoretisk Fysik, and Nordita, Copenhagen). Phys. Letters, 3: 329-31 (Feb. 15, 1963). (In English)

An energy-momentum complex that meets the objections raised against Einstein's expression is applied to the exact solutions of field equations for an axisymmetric, insular system of matter that emits gravitational waves into the surrounding empty space. (C.E.S.)

16833 THE EXTRACTION OF A NEGATIVE HYDROGEN ION BEAM FROM A DUO-PLASMATRON SOURCE. A. B. Wittkower, R. P. Bastide, N. B. Brooks, and P. H. Rose (High Voltage Engineering Corp., Burlington, Mass.). Phys. Letters, 3: 336-7(Feb. 15, 1963). (In English)

An attempt to increase the yield of directly extracted negative hydrogen ions by variations in the geometry of a duo-plasmatron ion source is described. Measurements show that the negative ion beam thus formed avoids several disadvantages and emerges as a beam of exceptionally good quality. (C.E.S.)

16834 SPECIFIC HEAT OF LEAD BETWEEN 0.3 AND 4°K. P. H. Keesom and B. J. C. Van der Hoeven, Jr. (Purdue Univ., Lafayette, Ind.). Phys. Letters, 3: 360-1 (Feb. 15, 1963). (In English)

The electronic contribution to the specific heat of lead for a sample of 1.293 moles (99.999% purity) was measured between 0.3 and 4°K and the results in the normal and superconductive states were presented. (C.E.S.)

16835 AN INVESTIGATION OF QUASI STATIONARY STATES OF THE TWO-ELECTRON ATOMIC SYSTEMS WITH A SPECIAL STUDY OF NEGATIVE ATOMIC IONS. Erling Holoeien (Univ. of Oslo). Phys. Norvegica, 1: 53-111(1961-62). (In English)

The problem of finding quasi-discrete energy solutions of the non-relativistic Schrödinger equation when using conventional methods of approach is considered. The application of the method of configurational interaction based on associated Laguerre functions with single orbital exponent in the spin-orbitals is theoretically discussed. Investigations previously reported were extended to the $(2p^2)^3P$ state of He. A theoretical and an experimental analysis of the structure of negative atomic ions are given. The method of configurational interaction and some semi-empirical methods are then applied to finding bound quasi-discrete states in H^-, He^-, and Li^-. (auth)

16836 ELECTRON EJECTION FROM METALS DUE TO 1- TO 10-kev NOBLE GAS ION BOMBARDMENT. I. POLYCRYSTALLINE MATERIALS. G. D. Magnuson and C. E. Carlston (General Dynamics/Astronautics, San Diego, Calif.). Phys. Rev., 129: 2403-8(Mar. 15, 1963).

A method is described that enables measurements to be made of the secondary electron emission coefficient, γ, for ions on materials for which γ is difficult or impossible to measure by the "flashing" or heating technique. The method allows operation in a high-vacuum (10^{-8} Torr) system. Results for γ are presented for Ar^+ on Zr, Cu, Mo, Ni, Ta, and Al, and for Ne^+, Kr^+, and Xe^+ on Cu and Mo in the energy range 0.5 to 10.0 kev. Comparisons with theories and experimental results are made. (auth)

16837 ELECTRON EJECTION FROM METALS DUE TO 1- TO 10-kev NOBLE GAS ION BOMBARDMENT. II. SINGLE CRYSTAL. G. D. Magnuson and C. E. Carlston (General Dynamics/Astronautics, San Diego, Calif.). Phys. Rev., 129: 2409-12(Mar. 15, 1963).

The secondary electron ejection coefficient is measured for the three low-index planes of copper single crystals using a sputtering technique to maintain monatomically clean surfaces. The ion used is Ar^+ in the energy range 0.5 to 10.0 kev. The planes investigated are the (100), (110), and the (111) planes. A simple geometrical model based on the opacity of the lattice in different crystallographic directions is found to agree with the experimental results at higher energies. (auth)

16838 EFFECT OF FLUXOID QUANTIZATION ON TRANSITIONS OF SUPERCONDUCTING FILMS. M. Tinkham (Univ. of California, Berkeley). Phys. Rev., 129: 2413-22(Mar. 15, 1963).

An elementary theory is presented for the transition of a superconducting film in the presence of a perpendicular magnetic field. The theory is based on the Ginzburg-Landau theory, with emphasis on the consequences of fluxoid quantization. The theory predicts that the transition occurs at a field $H_T(T) = 4\pi\lambda_e^2(T)H_{cb}^2(T)/\varphi_0$, where $\lambda_e(T)$ and $H_{cb}(T)$ are the penetration depth and bulk critical fields respectively, and φ_0 is the flux quantum hc/2e. Experimental data agree with this result if the transition is determined by measuring thermal conductivity or flux penetration. The resistive critical field for full normal resistance appears to be about twice this value, probably because of a residual filamentary structure. The theory also predicts that the angular dependence of the transition field should be given by $(H_T \sin\theta/H_{T\perp}) + (H_T \cos\theta/H_{T\parallel})^2 = 1$. This unusual form agrees with thermal conductivity measurements. The same theory leads in an elementary way to a quantitative interpretation of the observed periodic variation of T_c with flux through a cylinder. The results for the maximum change is $\Delta T_c/T_c = \varphi_0^2/[32\pi^3R^3\lambda_e^2(0)H_{cb}^2(0)]$. This agrees with the experimental value if $\lambda_e(0) = 4700$ Å, whereas from the limited mean free path in the sample it is estimated that $\lambda_e(0) \approx 2000$ Å. The agreement is probably within the uncertainties as to the details of the transition region. The theory also gives a semiquantitative account of the observed parabolic background effect. (auth)

16839 DIRECT SPIN-LATTICE RELAXATION PROCESSES. J. W. Culvahouse, Wesley P. Unruh, and David K. Brice (Univ. of Kansas, Lawrence). Phys. Rev., 129: 2430-40(Mar. 15, 1963).

A spin-lattice Hamiltonian for direct processes (the dynamic spin Hamiltonian) is defined that contains the effective spin operator and nuclear spin operator used in the static spin Hamiltonian. From the form of the dynamic Hamiltonian, certain combinations of the lattice operators can be identified as the dynamic analog of the static spin Hamiltonian parameters. The direct relaxation rates can be expressed in terms of spectral densities of the products of the dynamic spin Hamiltonian parameters. Assuming that the interaction of the ion with the crystal is adequately described by a crystal field, the sources of which are characterized by a symmetry group, it is possible to express the spectral densities involved in the spin-lattice relaxation in terms of the spectral densities of the normal modes of the complex. The symmetry of the complex and the crystal is used to limit the number of independent spectral densities of the normal modes without making any detailed assumptions about the lattice phonons nor the way that the sources of the crystal field participate in the lattice vibrations. Particular attention is given to the case of a Kramers doublet with hyperfine structure, and the matrix elements of the spin-lattice Hamiltonian between the eigenstates of the static spin Hamiltonian are given explicitly. These results are applied to the case of divalent cobalt in a nearly cubic field, and it is found that all twenty-two of the relaxation rates between levels for which the energy separation is $\sim g\beta H$ for any direction of the applied field may be expressed in terms of four constants if the nuclear quadrupole interaction is ignored. The effect of the dynamic hyperfine interaction is found to be large. Since all of the relaxation rates depend on the direction of the applied magnetic field, the four constants can be overdetermined by experimental measurements of the direct relaxation processes. (auth)

16840 DIELECTRIC CONSTANT OF A SUPERCONDUCTOR. Richard E. Prange (Univ. of Maryland, College Park). Phys. Rev., 129: 2495-2503(Mar. 15, 1963).

The longitudinal dielectric constant is calculated for the extended Bardeen-Cooper-Schrieffer model of a superconductor. An explicit formula is obtained, which can be evaluated numerically. The competition between collective and single-particle effects is pronounced, so that the dielectric function differs remarkably from the most elementary approximations to it. However, the dielectric function of the superconductor does not differ greatly from that in the normal metal in either the high-frequency or static limit, regardless of the wavelength. This prevents the modifications resulting from superconductivity from being readily observed. In particular, the shift in the static polarizability should cause very small shifts in the phonon speed, so small that no effect on the lattice specific heat should be observed. (auth)

16841 LOW-FREQUENCY MAGNETOPLASMA RESONANCE IN METALS. M. T. Taylor, J. R. Merrill, and R. Bowers (Cornell Univ., Ithaca, N. Y.). Phys. Rev., 129: 2525-9(Mar. 15, 1963).

A low-frequency magnetoplasma resonance, which is related to the "whistler" of ionosphere physics and the "helicon" resonance, is described. A sensitive method for observing this resonance is described. It involves the use of a diode ring demodulator as a phase-sensitive detector. The method is used to study the resonance quantitatively in Cu, Ag, Au, and Pb; resonances are also observed in Sn, Zn, Cd, and Hg. Analysis of the data yields values for the Hall coefficient and resistivity as a function of magnetic field. The results obtained for the noble metals and Pb by this probeless method are in agreement with those obtained using conventional methods. (auth)

16842 ALTERNATE METHOD OF MEASUREMENT OF THE POLARIZATION OF LIGHT EMITTED BY HELIUM ATOMS EXCITED BY ENERGETIC ELECTRONS. Robert H. McFarland and Edward A. Soltysik (Univ. of California, Livermore). Phys. Rev., 129: 2581-2(Mar. 15, 1963). (UCRL-7037)

Previous measurements on the polarization of helium light emitted by atoms excited by an electron beam have resulted from the observation of the intensity of the light at right angles to the direction of the electron beam. Polarization was determined in terms of the relative intensities of the components of this light whose electric vectors were oriented parallel to and at right angles to the direction of the electron beam. Because of the disagreement between experiment and theory, an alternate method in which the angle θ between the line of observation and the electron beam could be altered was used. After correcting the effective volume of the reaction region observed, the total intensity of light at a given angle is related to that observed at 90° by the relation, $I_\theta = I_{90}(1 - \tau\cos^2\theta)$, where τ is the polarization. Results given show that for $\lambda = 4922$ Å, relative changes of polarization with electron energy are similar to those observed with the previously described more sensitive method. The trend of the polarization toward zero at the onset of excitation was again observed. (auth)

16843 ROTATIONAL INVARIANCE AND THE S MATRIX IN NONRELATIVISTIC QUANTUM MECHANICS. R. Fong and J. Sucher (Univ. of Maryland, College Park). Phys. Rev., 129: 2824-9(Mar. 15, 1963).

The connection between an observable invariance property of the scattering matrix and the interaction, V, generating

the scattering, is studied for a particlar case: rotational invariance in nonrelativistic "potential" scattering. It is shown that a determination that the scattering cross section depends only on the angle between the incident and outgoing beams by no means implies that V is invariant under rotation. This is true even if coherent incident beams are used to probe the target. Some aspects of these results and their relevance for the construction of physical theories are briefly discussed. (auth)

16844 INVARIANT FUNCTIONS IN NONRELATIVISTIC THEORY. M. Bolsterli (Universitet, Copenhagen). Phys. Rev., 129: 2830(Mar. 15, 1963).

Galilean invariance is applied to extract the invariant parts of matrix elements of particle creation and annihilation operators. A method for solving the N-particle problem in terms of N to N + 1 particle amplitudes is presented. (auth)

16845 SPIN-ORBIT COUPLING IN THE BAND STRUCTURE OF MAGNESIUM AND OTHER HEXAGONAL-CLOSE-PACKED METALS. L. M. Falicov and Morrel H. Cohen (Univ. of Chicago). Phys. Rev., 130: 92-7(Apr. 1, 1963).

A calculation of the spin-orbit splitting of the energy levels at the corner of the Brillouin zone in Mg is performed using a six orthogonalized-plane-wave approximation. The parameters of the wave functions were taken from an existing calculation by one of the authors. The corresponding splittings for Be, Zn, Cd, and Tl are estimated from spectroscopic values of the atomic splittings. The changes in the topological properties of the Fermi surface caused by the spin-orbit splitting are discussed as well as the implications of these changes for various physical properties. (auth)

16846 EFFECT OF CORRELATION ON THE HYPERFINE INTERACTION IN LITHIUM. K. F. Berggren and R. F. Wood (Uppsala Univ.). Phys. Rev., 130: 198-204 (Apr. 1, 1963).

The results of calculations of the hyperfine interaction in the ground state of lithium, using well-correlated wave functions, are reported. An analysis of the wave functions is made in terms of operators that solve the general doublet function into two components, one of which is characterized by a spatially symmetric core function. The calculations show that this component with the spatially symmetric core can give very good values for both the energy (−7.47630 au) and the hyperfine interaction (98.8% of experiment). The inclusion of the second doublet component and some quartet component in the wave function has very little effect on either the energy or the hyperfine interaction. These results are discussed and compared with those obtained with the unrestricted Hartree-Fock (UHF) method. The conclusion is reached that the usual interpretation of the results obtained for lithium with the UHF method is not entirely acceptable. (auth)

16847 BORN CROSS SECTIONS FOR INELASTIC SCATTERING OF ELECTRONS BY HYDROGEN ATOMS. IV. APPROXIMATE VALUES FOR ALLOWED TRANSITIONS UP TO n = 10. Gerard C. McCoyd (St. John's Univ., Jamaica, N. Y.) and S. N. Milford. Phys. Rev., 130: 206-10(Apr. 1, 1963).

The Born total cross section is calculated for the inelastic scattering of electrons by hydrogen atoms undergoing the transitions: 10s → 11p and 10,9 → 11,10. By means of interpolation and extrapolation the cutoff momentum $K_c a_0$ is estimated for all transitions of the type $\Delta n = +1, +2$, $\Delta l = +1$, for n = 1 through 10. These are used to construct tables which provide a simple estimate of the Bethe total cross section. (auth)

16848 STATE-DEPENDENT MASS CORRECTIONS TO HYPERFINE STRUCTURE IN HYDROGEN ATOMS. Morton M. Sternheim (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 130: 211-22(Apr. 1, 1963). (BNL-6373)

The $\alpha^2 m/M$ corrections to the ratio of the hyperfine structure of the 1s and 2s states of hydrogenic atoms were evaluated using a Foldy-Wouthuysen reduction of the Dirac hamiltonian for the electron plus additional nuclear motion terms. The covariant two-fermion Bethe-Salpeter equation gives the same result, as does an approximately covariant calculation based on the Breit equation, a simple nuclear model, and the correspondence principle. In units of 10^{-6}, the $\alpha^2 m/M$ corrections to $R = (8\nu_2/\nu_1) - 1$ total -0.115, -0.029, and -0.101 for H, D, and T, respectively. The corresponding theoretical R values are 34.45 ± 0.02, 34.53 ± 0.02, and 34.46 ± 0.02. These agree with the available experimental values that are 34.495 ± 0.06 and 34.2 ± 0.6 for H and D, respectively. (auth)

16849 SEARCH FOR A SLOW COMPONENT IN ALPHA IONIZATION. Z. Bay and R. M. Pearlstein (National Bureau of Standards, Washington, D. C.). Phys. Rev., 130: 223-7(Apr. 1, 1963).

Delayed ion production was advanced as the reason for the difference in W (average energy expended in the creation of an ion pair) obtained by fast and slow collection of the ionization from alpha particles in gases. In order to determine whether such slow components exist, the slow and fast measuring methods are applied simultaneously to a single gridded chamber. The results in Ar, 90% Ar + 10% CH_4, and N_2 for alpha energies ranging from 1.5 to 4 Mev show that no such slow components exceeding the uncertainty of the measurements (< 0.5%) are present. This indicates that (at least in the above cases) discrepancies between slow and fast methods in past measurements are not due to physical effects. (auth)

16850 N/D METHOD FOR COMPLEX PARTIAL WAVES. K. Bardakci (Univ. of Minnesota, Minneapolis). Phys. Rev., 130: 369-80(Apr. 1, 1963).

Conditions on complex partial-wave amplitudes necessary and sufficient for the validity of the Mandelstam representation were derived for both nonrelativistic potential scattering and relativistic two-particle scattering. These conditions were used to obtain iterative solutions to the nonrelativistic scattering problem with a given potential (restricted to superposition of Yukawa potentials), and to the relativistic problem in the elastic unitarity approximation with a given discontinuity across the left-hand cut. In the first case, the method used reduces to the well-known determinantal method for physical partial waves, and in the second case, it is a natural generalization to the N/D method to complex values of l. The Regge poles, given by the zeros of the denominator, can be studied in a perturbative expansion in terms of the strength of the potential. Several applications are pointed out. (auth)

16851 COMMUTATION RELATIONS AND CONSERVATION LAWS. Julian Schwinger (Harvard Univ., Cambridge, Mass.). Phys. Rev., 130: 406-9(Apr. 1, 1963).

The response of a physical system to external electromagnetic and gravitational fields, as embodied in the electric current and stress tensor conservation laws, is used to derive the equal-time commutation relations for charge density and energy density. (auth)

16852 LIMITS OF ERROR FOR THE ELECTRON DENSITY, SPIN DENSITY, AND ATOMIC FORM FACTOR IN QUANTUM MECHANICAL CALCULATIONS. L. B. Rédei (Upsala Univ.). Phys. Ref., 130: 420-4(Apr. 1, 1963).

Explicit formulas are given for the limits of error at an arbitrary point in the electron density, spin density, and form factor derived from an approximate wave function. In the derivation extensive use is made of some previous results by Kinoshita. The main treatment is preceded by a short discussion of some of the more mathematical aspects of the problem, and a simple numerical example is given. (auth)

16853 APPLICATION OF THE VARIATION METHOD TO FIELD QUANTIZATION. L. I. Schiff (Stanford Univ., Calif.). Phys. Rev., 130: 458-64(Apr. 1, 1963).

The application of the variation method to a simple field theory is shown. A representation is found in which the state functions are emphasized. Variational trial forms are chosen for these, and optimized by making the expectation value of the field Hamiltonian stationary. Only the simplest case of a neutral, spin-zero, boson field with a fourth-power self-coupling term is considered here, but it is hoped that with further elaboration this may in the future lead to a description of the multipion resonances. The variation method has the advantage of avoiding any limitation on the strength of the self-coupling. Explicit results are obtained for the vacuum, single-particle, and two-particle (scattering and bound) states, and comparison is made with the determinantal method. Finally, a criterion for the variational stability of the vacuum state is obtained. (auth)

16854 SOME DYNAMIC ASPECTS OF THE CATHODE FALL REGION IN A D.C. GLOW DISCHARGE. P. J. Severin (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Physica, 29: 83-92(Jan. 1963). (In English)

To describe the cathode fall a pseudo electron plasma frequency and an ion plasma frequency are introduced as plasma parameters. These are related to the length d, the potential V_0 and the atomic mass M of the gas. The motions of electrons and ions are described. Collisions introduced for electron motion provide the maintenance mechanism as it is usually understood. For ion motion they determine the mean ion velocity $\bar{v} \sim E_0^{\frac{1}{2}}$. Finally the voltage-current-length relation is derived in two different ways yielding only slightly different expressions. (auth)

16855 ON MAGNETOHYDRODYNAMIC HYPERSONIC FLOW OVER A WEDGE. M. D. Ladyzhenskii. Priklad. Mat. i Mekhan., 27: 55-60(Jan.-Feb. 1963). (In Russian)

Hypersonic flow around a wedge, with internally excited magnetic field, was studied assuming a narrow turbulent flow between the solid and the shock wave. It is also assumed that the magnetic field is at an arbitrary angle to the body surface. The solution for the wedge pressure differs from Newton's, and a possibility of cavitation is recognized where the pressure under certain magnetic field effects becomes zero. The discontinuity points and cavitation position are found as functions of wedge opening angle and magnetic vector dip. (R.V.J.)

16856 COVARIANT QUANTUM FIELD THEORIES WITH INDEFINITE METRIC, AND THE LORENTZ COVARIANT LEE MODEL. J. L. Martin (National Physical Lab., Teddington, Middx, Eng.). Proc. Roy. Soc. (London), Ser. A, 272: 231-40(Mar. 5, 1963).

The covariant quantum theory of n scalar bosons is redeveloped, full allowance for the possibilities of negative energy and negative norm being made. The formalism is then reinterpreted as a non-interacting quantum field theory in a standard way; the indefinite metric now appears as a Hermitian operator η with eigenvalues ± 1. The invariant annihilation and creation field operators ϕ, ϕ^η that are characteristic of this formalism are found to retain a separate existence even when an interaction is introduced. The Hamiltonian form of the theory is developed, and provides an immediate reformulation (as a field theory) of the Lorentz covariant version of the Lee model that has been considered elsewhere. Certain features of the exact solution of this model suggest that the covariant field theory with indefinite metric is the correct formulation to adopt, provided that satisfactory supplementary conditions are imposed at a later state; it is certainly clear that the model cannot be formulated with positive-definite metric at the beginning in any simple way. It is unlikely that matters will be different for the quantum fields used to describe more realistic physical situations. (auth)

16857 RESEARCH ON DIRAC MAGNETIC POLES. Rev. Gen. Electronique, 17: No. 194, 55-6(Jan. 1963). (In French)

The nuclear emulsion study made at CERN to detect the point magnetic poles predicted by Dirac as sources of the electromagnetic field is briefly described. No results are reported as the emulsions are still being scanned. (J.S.R.)

16858 THE MATHEMATICAL THEORY OF PLANE GRAVITATIONAL WAVES IN GENERAL RELATIVITY. Hyoitiro Takeno. Sci. Rept. Res. Inst. Theoret. Phys., Hiroshima Univ., No. 1, 1-134(1961). (In English)

A concept of plane gravitational waves is introduced, with emphasis on the mathematical aspect of the theory. The case of purely gravitational plane waves is generalized to include the case in which electromagnetic waves coexist with the gravitational waves. Exact solutions of the field equations are considered. Plane-wave solutions in general relativity are compared with those in the unified theory of non-symmetric fields. These solutions, obtained under severely restricted conditions, cannot assert any decisive conclusion on the general characters of either theory, but some true characters of the theories reveal themselves. (C.E.S.)

16859 WAVE GEOMETRY. Yositaka Mimura and Hyôitirô Takeno. Sci. Rept. Res. Inst. Theoret. Phys., Hiroshima Univ., No. 2, 1-121(1962). (In English)

For the unification of quantum mechanics and relativity theory, an alteration of the concept of space-time is inevitable. Research into space and time is carried out simultaneously with the laws of physics. The essential ideas contained in quantum mechanics and relativity theory are analyzed, on the basis of geometrization of physical phenomena, and are amalgamated into a natural form. (C.E.S.)

16860 EFFECT OF GAMMA RADIATION ON THE PIEZOELECTRIC AND ELASTIC PROPERTIES OF TRIGLYCINSULFATE CRYSTALS. I. M. Sil'vestrova and V. A. Yurin (Inst. of Crystallography, Moscow). Soviet Phys.-Solid State (English Transl.), 4: 1698-1703(Mar. 1963).

A discussion is presented of the dependence of the elastic constant s_{ij}^E, the coefficient of the electromechanical bond k_{ij}, and the piezoelectric modulus d_{ij}, on temperature and also the dependence of d_{ij} on a constant field for triglycinsulfate crystals irradiated with gamma rays. It is shown that to achieve a piezoeffect in irradiated crystals it is not necessary to apply constant polarizing field. (auth)

16861 INFLUENCE OF PERIODICITY DISTRIBUTIONS ON ANOMALOUS TRANSMISSION OF X RAYS. INTEGRAL CHARACTERISTICS OF ANOMALOUS TRANSMISSION OF X RAYS. A. M. Elistratov and O. F. Efimov (Semiconductor Inst., Leningrad). Soviet Phys.-Solid State (English Transl.), 4: 1757-66(Mar. 1963).

Experimental results are discussed for anomalous transmission of x rays through germanium single crystals. These results were obtained by means of a two-crystal spectrometer using (220) Bragg reflections in the Bragg-Laue setup with the crystals in the (2, −2) positions. The CuK_α radiation was used as a monochromatic source, and a scintillation device as receiver. The dependence of the integrated intensity of the anomalously transmitted radiation T_i and the Laue reflection R_i on specimen thickness was determined for the range $3.14 \leq \mu_i t \leq 82.04$ in a germanium single crystal having few dislocations. The range has been determined in which the "thick" crystal approximation ($T_i = R_i = i$) is valid. It was shown experimentally and theoretically that in this range the logarithm of the quantity $\underline{i}$ obeys the linear relationship $\ln i = -\mu_i t + y_i$. On the basis of this, were two quantities introduced for approximation of "thick" crystal characteristics: the integral (effective) coefficient of absorption by diffraction μ_i, and another characteristic quantity of total transmission y_i, which is equal to the intercept on the ordinate axis of the straight line portion of the ln i curve. (auth)

16862 LUMINESCENCE OF ALKALI HALIDE PHOSPHORS ACTIVATED WITH EUROPIUM. J. Kirs and A. Niilisk. Tr. Inst. Fiz. i Astron., Akad. Nauk Est. SSR, No. 18, 36-50(1962). (In Russian)

Excitation and emission spectra of NaCl-Eu, KCl-Eu, KBr-Eu and KI-Eu phosphors were investigated. Similarly, the optical flash, thermo-luminescence and absorption spectra of a few of these phosphors after x-excitation were examined. It is shown that recombination luminescence of alkali halide phosphors activated with europium is due to the release of electrons from trapping centers. Sensitized luminescence of manganese in NaCl-Eu phosphor with a resonance mechanism of energy transfer is revealed. (auth)

16863 EFFECTS INDUCED BY FAST-MOVING ARTIFICIAL SATELLITE IN IONOSPHERE OR INTERPLANETARY MEDIA. Ya. L. Al'pert, A. V. Gurevich, and L. P. Pitaevskii. Usp. Fiz. Nauk, 79: 23-80(Jan. 1963). (In Russian)

Theoretical studies were made of the interactions of a moving body in rarefied plasma assuming that the velocity of the moving body is much greater than the thermal velocity of the particles in the medium and the dimensions of the body are quite large in comparison to the Debye radius. The influence of an electric field on ion motion immediately behind the body, the problem of magnetic perturbations, and scattering of radio waves on the path made by the body when the effective cross section of the resonance region is increasing and $\epsilon \to 0$ were also studied, as well as the problems of heating, ionization, wave emissions, and disintegration of the body surface. (R.V.J.)

16864 NONEQUILIBRIUM DISTRIBUTION OF ENERGY ACCORDING TO THE OSCILLATION FEEEDOM IN GASES. A. I. Osipov and E. V. Stupochenko. Usp. Fiz. Nauk, 79: 81-113(Jan. 1963). (In Russian)

Oscillation relaxation is studied considering the structure of shock waves in biatomic gases, absorption spectra of pulse photolysis products, ultrasonic wave dispersion theory, and chemoluminescence in combustion theory. The distribution of oscillation energies in systems with particle sources is studied by considering an equilibrium established in an initially nonequilibrium system and stationary or quasistationary (but nonequilibrium) distribution established by constant or slowly changing factors. 65 references are included. (R.V.J.)

16865 THE IONIZING POTENTIAL WAVES AT SPARK DISCHARGES. Essam Nasser (Univ. of California, Berkeley). Z. Physik, 172: 405-28(1963). (In German)

Extending earlier studies on spark breakdown, the development of the impulse prebreakdown streamers leading to complete breakdown were investigated. By taking advantage of the proportionality between point potential and length of the positive Lichtenberg figure produced, the potential of the streamer tips progressing from a point anode toward a plane cathode were determined. It was found that the streamer tip potential decreases as streamer advances. At voltages much lower than sparking potential this decrease is rapid. By approaching the sparking potential the loss of tip potential diminishes considerably near the anode. The decrease of potential remains very rapid near the cathode until sparking potential is reached. At the cathode the tip potential increases with the applied potential. At a certain value electrons are emitted from the cathode under the influence of high tip fields. These electrons are accelerated toward the tips forming avalanches by collision. These avalanches appear on the photographic film as minute dots whose number and density depend on the intensity of tip fields. If the applied potential exceeds the sparking voltage, tip potentials are recorded on the cathode between 15 and 25 kv. The avalanches formed in the high-intensity field region reach the critical size and form negative, anode-directed streamers. These streamers appear on the film as negative Lichtenberg figures. This ionizing potential wave, known as return stroke, travels along the channel of the positive primary streamer. It increases its ionization to such a degree that the main stroke can take place. (auth)

16866 EFFECTIVE MUTUAL FRICTION BETWEEN THE SUPERFLUID AND NORMAL COMPONENTS OF He II ALONG THE AXIS OF ROTATION. Dzh. S. Tsakadze (Inst. of Physics, Academy of Sciences, Georgian SSR). Zh. Eksperim. i Teor. Fiz., 44: 103-4(Jan. 1963). (In Russian)

Waves moving along vortex lines distort them. In contrast to the case when the normal component moves along a straight vortex line (which leads to a zero value of mutual friction), movement of the normal component along a curved line gives rise to a nonzero mutual friction between the two components. Data pertaining to measurement of this quantity under conditions of artificial generation of waves are presented. (auth)

16867 FORMATION OF A CENTRAL VORTEX IN ROTATING LIQUID HELIUM. Dzh. S. Tsakadze (Inst. of Physics, Georgian SSR). Zh. Eksperim. i Teor. Fiz., 44: 105-9(Jan. 1963). (In Russian)

An experimental study of the central macroscopic vortex in rotating helium is carried out. It is shown that the vortex is formed only in rotating He I due to the presence of a two-phase liquid-vapor system and is of an entirely classical nature. This viewpoint has been confirmed by modeling the effect in rotating water. Nevertheless this classical formation may be frozen when rotating He I passes through the λ-point and is transformed into rotating He II. The macroscopic vortex in He II is unstable and after a time disappears. (auth)

16868 THE MÖSSBAUER EFFECT FOR AN IMPURITY NUCLEUS IN A CRYSTAL. [PART] II. Yu. Kagan and Ya. A. Iosilevskii. Zh. Eksperim. i Teor. Fiz., 44: 284-302(Jan. 1963). (In Russian)

Resonance γ ray absorption by an arbitrary impurity nucleus in a crystal accompanied with a change of lattice states were considered. The connection of the one-quantum excitation probability with the vibrational spectrum of a crystal was analyzed and the absorption line intensity corresponding to the excitation of a given localized level was determined. The temperature-dependence of the Mössbauer effect and the one-quantum excitation probability is studied in detail taking into account, in particular, the role of the degeneracy. The results of calculations are given for the case of a simple unit cell lattice and nearest neighbor interactions. Obtained results are compared with available experimental data. (auth)

16869 QUANTUM MECHANICS. VOLUME I. OLD QUANTUM THEORY. Sin-itiro Tomonaga. Translated by Koshiba from Japanese. Series in Physics. New York, John Wiley and Sons, Inc., 1962. 326p. $12.50.

The first of three volumes on quantum theory treats the development of the theory from Planck to Heisenberg, through Einstein, Bohr, and others. The discovery of the energy quantum, the corpuscular nature of light, the old quantum mechanics, and the origin of matrix mechanics are topics examined. (D.C.W.)

16870 A STUDY OF THE PENETRATION OF LOW ENERGY RADIOACTIVE KRYPTON IONS INTO SINGLE CRYSTAL SILICON IN A GLOW DISCHARGE. Charles Yale Bartholomew, Jr. Thesis, Bethlehem, Penna., Lehigh Univ., 1962. 124p.

A method was developed to measure the penetration depth of low-energy ions of the radioactive gas Kr^{85} into single-crystal silicon during a glow discharge. The Kr^{85} was mixed with Ar or Ne as a carrier gas during the discharge. Penetration depth, defined as that thickness of surface layer of the sample which contains 90% of the deposited Kr^{85} atoms, was determined by using radioactive counting methods and a special chemical stripping technique. This stripping technique was used to remove 12 Å thick layers of sample per stripping. Penetration depths ranged from 10 to 175 Å, depending on the total number of incident particles in the bombardment, for Kr^{85} ions of 500 to 1000 volt energy. Penetration depth was found to increase with applied voltage and also with the total number of atoms incident during the bombardment. This latter effect was not due to diffusion, since measurements of the diffusion coefficient of Kr^{85} in the silicon surface layer showed it to be much too small. To explain the increase in penetration depth with increase in total number of incident particles, it seems necessary to assume some sort of interaction of incident atoms with those previously deposited in the sample. (Dissertation Abst., Vol 23, No. 7)

16871 IMPERFECTIONS AND THE INTERMEDIATE STATE OF SUPERCONDUCTORS. Ronald B. Goldner. Thesis, Lafayette, Ind., Purdue Univ., 1962. 161p.

A study of the role played by imperfections in determining the properties of superconductors in the intermediate state is described. The concept of a position-dependent surface energy between normal-conducting and superconducting domains, which can become negative in the vicinity of imperfections, is emphasized. An extensive review of pertinent experimental and theoretical investigations of the properties of the intermediate state, and related effects, is presented. The results of an experiment on the intermediate-state behavior within a transverse Pb cylinder are described. Based upon the results of this experiment, the interphase surface energy parameter, Δ, for Pb at 4.2°K is estimated to be $\lesssim 1.2 \times 10^{-5}$ cm. This agrees within 10% of a theoretical estimate based upon the Bardeen and Landau-Ginsburg theories. An intermediate-state model based upon a periodic array of imperfections, at which there exists a negative interphase surface energy, is proposed. Approximate solutions for this model agree qualitatively with the experimental results on transverse Pb cylinders. A thermodynamic argument is developed which shows that trapped flux is unstable in a singly-connected superconductor not having regions of negative interphase surface energy. This argument lends support to the concept of a negative interphase surface energy. (Dissertation Abst., Vol 23, No. 7)

16872 NASA RESEARCH ON HEAVY-PARTICLE ELECTROSTATIC THRUSTORS. William R. Mickelsen (National Aeronautics and Space Administration, Cleveland). Preprint Paper No. 63-19. New York, Institute of the Aerospace Sciences, 1963. 30p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Thrustor inefficiency and thrustor operation at off-optimum specific impulse seriously decrease electric spacecraft performance. It appears that existing atomic-ion electrostatic thrustors designs will not have adequate efficiency at low specific impulse, but heavy-particle thrustors might have high efficiency in the entire specific impulse range of interest. The NASA research program on heavy-particle thrustors is described. Some preliminary data on heavy-molecule thrustors are shown, and some recent colloidal-particle thrustor work is discussed. (auth)

16873 TEST RESULTS FOR A CESIUM ELECTRON BOMBARDMENT ION MOTOR. R. C. Speiser, W. D. Kilpatrick, and G. R. Reid (Electro-Optical Systems, Inc., Pasadena, Calif.). Preprint Paper No. 63-75. New York, Institute of the Aerospace Sciences, 1963. 20p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Electron bombardment ion motors using cesium as an expellant were tested and discharge and engine characteristics studied. Cathode configurations heated entirely by power delivered from the arc provided mass utilization efficiencies of 90 percent at 650 ev/ion. The engines achieved overall efficiencies of 70 to 80 percent at specific impulses of 6000 to 8500 seconds and thrusts up to 10 mlb. (auth)

16874 PROCEEDINGS OF THE INTERNATIONAL SYMPOSIUM ON SPACE PHENOMENA AND MEASUREMENT, DETROIT, MICHIGAN, OCTOBER 15-18, 1962. IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 1-311(Jan. 1963). $10.00.

Thirty-eight papers are included; separate abstracts have been prepared for 32. Five papers were previously abstracted in NSA. The paper remaining deals with a low-field helium magnetometer. (T.F.H.)

16875 THE BOMB-PRODUCED RADIATION BELT. W. N. Hess (National Aeronautics and Space Administration, Greenbelt, Md.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 8-11(Jan. 1963).

The distributions of electrons trapped in the earth's magnetic field, produced by a 1.4-Mt nuclear explosion at altitude of 400 km in the Central Pacific Ocean, are measured by several satellites. The decay of this bomb-produced radiation belt is described, in terms of the time since the

explosion (July 9, 1962) and the distance from the earth. The effects of the electrons on the satellite electrical systems are also discussed. (T.F.H.)

16876 RADIATION DOSAGE DUE TO NEUTRONS PRODUCED IN A VEHICLE BY PROTONS IN THE TRAPPED RADIATION BELT. J. P. Martin (RIAS, Baltimore), L. Witten, and L. Katz. IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 12-16(Jan. 1963).

The rate of production of neutrons by geomagnetically trapped protons incident on a vehicle was measured by a neutron counting system carried into the trapped radiation belt by a pod flow piggy-back on an Atlas rocket. The flux of neutrons produced by radiation belt protons incident on the pod was determined to be at least 700 neutrons/(cm^2 sec); the actual value depended somewhat on the energy spectrum of the neutrons. This flux was estimated to be equivalent to a dose rate in tissue of 0.10 rems/hr. On the basis of proton flux measurements made in the radiation belt, a calculation was made of the tissue dosage that would have been received in the same environment directly from protons. These calculations were made by obtaining a numerical integration of the dE/dx times RBE times flux product over the entire energy spectrum. The total dose calculated amounted to 2.78 rems/hr. Further calculations were made to estimate the dose rates which would have been received by tissue in the same environment but with varying amounts of shielding around the vehicle. The proton dose was reduced by the shield but the neutron dose increased as the shielding thickness increased. The neutron dose equaled the proton dose at 0.3 rems/hr when aluminum shielding of 2.6" surrounded the vehicle, and exceeded the proton dose with thicker shielding. The calculations were based on an empirical neutron production cross section obtained from the neutron measurements and the geometrical arrangement of the pod. The estimates showed that the dosage from neutrons produced inside a shielded vehicle becomes the predominant hazard as the shielding thickness becomes larger. (auth)

16877 SHIELDING PROBLEMS FOR MANNED SPACE MISSIONS. R. K. Wilson (General Dynamics Corp., Fort Worth, Tex.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 17-23(Jan. 1963).

In order to estimate the magnitude of the radiation hazard presented by solar flare and Van Allen belt proton radiation, a simple spherical-shell shield geometry was chosen and physical dose calculated as a function of shell thickness. Both point-target and body-phantom definitions of dose were used to define the primary particle dose. The secondary particles formed in the shield were shown to contribute a significant fraction of the total dose in the case of a given flare spectrum and an aluminum shield. (auth)

16878 AN ANALOG TO DIGITAL CONVERTER CAPABLE OF NANOSECOND RESOLUTION. A. A. Fleischer and E. Johnson (Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 31-5(Jan. 1963).

Circuitry is designed and constructed that is able to analyze and reproduce accurately the slope and pulse height at various points along a rapidly changing signal which occurs only once. The signal is analyzed at 10-nanosecond intervals. The circuitry is also able to sense a zero slope per unit time and in this mode it can be used as a multichannel pulse height analyzer with a dead-time that is dependent only on the rise time of the pulses it is analyzing (pulse-pair resolution of 10^{-7} seconds for random pulses with a 0.1-μsec rise time is possible). The model under discussion has a maximum storage capacity of 160 channels with 2^8 bits of information per channel. (auth)

16879 N-DECADE COUNT-RATE-METER WITH AUTOMATIC SCALE CHANGE FEATURE AND RESOLUTION OF ONE DECADE. Stan Thomas (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 36-41(Jan. 1963). (UCRL-7089)

Monitoring radiation fields in space often requires coverage of large ranges of count rate which, if count rate meters are used, entails either a decrease in resolution resulting from coverage of the entire range with one rate meter, or the use of several telemetry channels if several different rate meters are used. A method permitting the desired resolution to be obtained by use of as many count rate meters as required is described that limits the number of telemetry channels needed to two. A circuit switches one telemetry channel from one rate meter to the next as the input rate changes, while the other telemetry channel is used to monitor which rate meter is being read out. (auth)

16880 THE NEED FOR FLEXIBILITY IN AMPLIFIER DESIGN. W. W. Goldsworthy (Univ. of California, Berkeley). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 61-7(Jan. 1963).

Notable pulse amplifiers are described. Among these are the DD-2, A-8, and alpha amplifiers. Although these amplifiers show exceptional performance in their particular specialized application, all lack the flexibility desired in a general-purpose amplifier. What is needed is an amplifying system possessing the best basic features of these amplifiers, with the addition of features to obtain greater flexibility and therefore greater utility. An amplifying system of this type is described. (auth)

16881 TORY II-C NUCLEAR INSTRUMENTATION SYSTEM. G. St. Leger-Barter (Univ. of California, Livermore). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 68-73(Jan. 1963). (UCRL-7073)

The design of the nuclear instrumentation system for the Pluto series of nuclear ramjet test reactors is an attempt to provide a very flexible nuclear sensing system that will be adequate for Tory II-C and following test reactors. The nuclear detectors will be exposed to the leakage neutron flux from the reactor during operation. Since leakage flux is proportional to reactor power, the neutron detectors will give a measure of reactor power. A difficulty in providing nuclear instruments for this reactor is the uncertainty in the neutron energy spectrum of the leakage flux at the detectors. Since detector response varies with neutron energy, a large margin of flexibility is desirable. A difficulty that may be encountered is a significant shift in neutron energy spectrum at high power and temperature. This shift would make indicated nuclear power nonlinear with calorimetric power. A difficulty in insufficient instrument overlap is encountered with the Tory II-A experiment, where a large margin of flexibility could be useful. The detector placement for the Tory II-A experiment has the power range detectors in line with the reactor and main air pipe. At high air flows there is a much greater mass of air between the detectors and the reactor, allowing fewer neutrons to reach the detectors per unit reactor power. This result is the reason for the power range detectors being placed off to the side of the Tory II-C test vehicle. (auth)

16882 ANALYSIS OF TRANSISTOR FAILURE IN A NUCLEAR ENVIRONMENT. Frank W. Poblenz (Bendix

Corp., Southfield, Detroit). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 74-9(Jan. 1963).

A method is described for predicting transistor reliability as a function of nuclear radiation exposure, by the use of a given distribution. Graphical plots of seven different types of transistors show a-c gain degradation as a function of integrated neutron exposure. The plots are extended to include probability of failure to 0.1 and 0.01 per cent. The graphs are interpreted and the plotting technique and assumptions for extrapolation of the distribution used are discussed. (auth)

16883 CORRELATION OF RADIATION TYPES WITH RADIATION EFFECTS. V. A. J. van Lint and E. G. Wikner (General Atomic Div., General Dynamics Corp., San Diego, Calif.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 80-7(Jan. 1963).

The effects produced by different types of nuclear radiation can be compared by making use of information on radiation-effects mechanisms. Radiation-effects manifestations can be separated into three categories: transient radiation effects, which are caused by excited and ionized electrons; displacement radiation effects, which are manifestations of atoms displaced from their normal lattice sites in crystalline solids; and chemical radiation effects, which arise from molecular rearrangements occurring as a second stage to ionizing interactions. The effects produced by different primary radiations can be compared by first identifying the manifestation as belonging to one of these three types. For displacement effects, the relative cross sections for producing displaced atoms and the average size of the displacement cascade produced by the primary recoil atom are computed. Similarly, for transient and chemical effects, the ionization density produced by the incident radiation is computed. Examples of the pertinent cross sections are calculated for electrons, gamma rays, protons, and neutrons of various energies. (auth)

16884 THE DEGRADATION OF SOLAR CELLS UNDER VAN ALLEN RADIATION. F. M. Smits (Sandia Corp., Albuquerque, N. Mex.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 88-96(Jan. 1963). (TID-17079; SCDC-2829)

The electrons and protons of the Van Allen belt cause radiation damage to silicon solar cells that results in a gradual reduction of the power output of solar power plants on satellites passing through the belt. The study of the radiation damage caused by monoenergetic electrons and by monoenergetic protons of various energy indicates that n-on-p solar cells are substantially more radiation-resistant than p-on-n cells. From such studies and a knowledge of the composition of the Van Allen belt, a flow of (for example) 1-Mev electrons can be determined that will cause the same radiation damage per unit time to a bare solar cell as the Van Allen belt spectrum would produce under a given shielding. Observations of radiation damage of satellites are also conveniently expressed in terms of such an equivalent flux. Measurements of solar-cell short-circuit current changes and changes in the current gain of specially designed highly radiation-sensitive transistors are performed on the Telstar satellite. The results agree with the radiation damage expected from the observed particle flux, and indicate that solar power is practical for long-life satellites passing through the Van Allen belt, particularly if n-on-p solar cells are used. (auth)

16885 RADIATION DAMAGE BY CHARGED PARTICLES IN SILICON JUNCTION DETECTORS. G. Dearnaley (Atomic Energy Research Establishment, Harwell, Berks, Eng.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 106-10(Jan. 1963).

Over recent years silicon junctions have been developed as radiation detectors for a wide range of applications in nuclear physics. More recently they have been employed in a number of measurements of nuclear radiation in space. For this purpose they have several great advantages; they are compact, robust, and have low power requirements, while in addition they give a fast signal and can operate in conditions of high counting rate. However, since the properties of semiconductors depend markedly on a small concentration of impurity atoms and crystal defects they are particularly susceptible to radiation damage. The effects of heavy charged particles such as protons and alphas on Si junction detectors in space environments are studied. Measurements with Explorer XII showed a proton flux up to $7 \cdot 10^6$ protons/cm^2/sec/ster at a distance of 5 earth radii. The mode of damage by heavy particles, and experimental data on the effects of damage on the performance of silicon surface-barrier detectors, are discussed. (auth)

16886 THE ROLE OF ATOMIC COLLISIONS IN SPACE PHENOMENA. E. W. McDaniel, W. S. Barnes, J. W. Hooper, R. A. Langley, and D. W. Martin (Georgia Inst. of Tech., Atlanta). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 111-18(Jan. 1963).

Collisions involving electrons, photons, and atomic systems are important in upper atmospheric and astrophysical phenomena and in the exploration of space. Some of these types of reactions are enumerated and described. Examples are given of their significance with respect to diffusion in the atmosphere; radio communications and radar tracking; the excitation and study of the airglow and aurorae; the Van Allen radiation belts; estimation of densities, composition, and temperatures of nebulae and stellar atmospheres; the mapping of hydrogen in interstellar space; and the erosion of space vehicles and planets. Ion mobilities, ion-molecule reactions, ionization, and charge transfer are described. (auth)

16887 MEASUREMENTS ON CURRENT SHEETS IN PLASMAS. O. K. Mawardi and M. Naraghi (Case Inst. of Tech., Cleveland). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 119-23(Jan. 1963).

The acceleration of a gas undergoing ionization in a crossed electric-magnetic field leads to the formation of current sheets similar to those observed in coaxial plasma guns. The dynamics of such sheets is outlined. A mapping of the magnetic field in the vicinity of a current sheet is described. Conventional small search coils are used for the detection of this field. From the configuration of this field an attempt is made to understand the processes taking place in the sheet. All of the experiments described are performed on a plasma coaxial gun of small aspect ratio. (auth)

16888 INTERACTION OF RECOMBINING ATOMIC NITROGEN WITH GASEOUS PLASMAS. Thomas Marshall (Columbia Univ., New York) and E. A. McLennan. IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 124-35(Jan. 1963).

Experiments are reviewed that measure the three-body volume recombination coefficient of neutral nitrogen atoms in nitrogen gas, making use of an electron spin resonance (ESR) technique to determine the atomic concentration. The nitrogen atoms are created in an electrodeless discharge, and carried to the ESR detector by a stream of flowing gas. The temperature dependence of the atomic recombination coefficient near 300°K and the number of photons emitted in the Rayleigh afterglow bands per re-

combination are determined. It is found that the loss rate of nitrogen atoms is considerably enhanced when the atomic stream is exposed to a feeble d-c discharge. The removal mechanism appears to be one of ionization of nitrogen atoms by electronic bombardment followed by a comparatively rapid ambipolar diffusion. If, however, the stream of atoms passes through a region containing a decaying afterglow plasma in nitrogen where the electronic temperature is low, it is observed that the electronic ambipolar diffusion coefficient is enhanced in the presence of atoms. This result implies an energy transfer mechanism between the recombining atoms and the cool electrons. This effect is explored by observing the change in light emitted by the nitrogen electronic afterglow and the change in electronic concentration and electron-neutral collision frequency with microwaves upon introducing atoms into the afterglow plasma. (auth)

16889 WAVE PROPAGATION IN A COAXIAL GLOW DISCHARGE. E. K. Miller and A. Olte (Univ. of Michigan, Ann Arbor). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 136-45(Jan. 1963).

The propagation of electromagnetic radiation from 500 to 4200 Mc in a coaxial cage transmission line passing through a cylindrical discharge chamber is investigated experimentally. Measurements are conducted in argon, helium, and nitrogen gas at pressures between 0.09 and 2 mm Hg for a discharge-electromagnetic radiation interaction length of 30.48 cm. The results are compared with theory, using a Lorentzian model to describe the electron motion in the presence of the r-f field. A graphical method for determining the plasma frequency and electron momentum transfer collission frequency from measurements of the power transmission coefficient at two different radio frequencies is discussed. A comparison is made between the plasma frequency determined by this method and that obtained by the use of a cylindrical Langmuir probe. The electron momentum transfer collision probability is calculated from the r-f and probe data. (auth)

16890 PROPAGATION OF INFORMATION BEARING SIGNALS THROUGH SPACE. Richard F. Leach (Martin Co., Baltimore). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 146-52(Jan. 1963).

The distortion of a band-pass information-bearing signal by a medium is analyzed. The inverse of this analysis might be used to analyze the band-pass spectrum of an arbitrary medium. If the signal distortion is negligible, the signal is "narrow-banded." Narrow-bandedness is mathematically defined. (auth)

16891 PLASMA AND ENGINEERING PARAMETERS FOR A FUSION POWERED ROCKET. John L. Hilton (Aerojet-General Nucleonics, San Ramon, Calif.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 153-64(Jan. 1963).

Assuming a solution of plasma instability and confinement problems, a study is presented showing the relationship of pertinent plasma parameters. The reacting plasma is assumed within a multipolar magnetic confinement geometry. The power lost to neutrons by most fusion reactors shows that He^3-D is the unique fusion reaction suitable for space propulsion. The relationship of plasma particle density, ion temperature, and confining magnetic field to total fusion power is presented. The significant plasma losses of bremsstrahlung and gyromagnetic radiation are discussed. The consequences resulting from radiation are discussed. The consequences result.:g from different values of β (the ratio of plasma to magnetic confinement pressures) are investigated. A rough rocket motor optimization is performed with 25 megawatt power in the exhaust jet. This hypothetical rocket motor has a peak I_{sp} of 4.7×10^5 to 8×10^4 seconds depending on the electron temperature, and is capable of operating down to a I_{sp} of approximately 5000 seconds by adding extra cold propellant. When operating at the high I_{sp} the fuel consumption is 2.2 to 44 lbs/day, depending on the electron temperatures. The resulting estimate of fusion rocket motor power to weight ratios is 0.7 to 2 lbs/kwatt for β values above 0.2. The relationship of payload fraction to space flight time for a simple Jupiter mission is presented for both the proposed fusion and uranium-fission electric systems. (auth)

16892 INSTRUMENTATION FOR SPACE RADIATION MEASUREMENTS. PART I. J. B. Reagan and R. V. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 172-7(Jan. 1963).

A description is given of a system of scintillation detectors employed as energy threshold devices for the detection of energetic electrons and protons; a phoswich detector, for the detection of neutrons in the upper atmosphere in the presence of high charged-particle fluxes; and a low-energy electron spectrometer using Geiger-Mueller tubes, for the detection of auroral electrons. The means used for increasing the reliability of these detectors for aerospace and space uses are discussed. The performance of the detectors in space flights, balloon flights, and satellites is also outlined. (T.F.H.)

16893 INSTRUMENTATION FOR SPACE RADIATION MEASUREMENTS. PART II. J. H. Rowland, J. C. Bakke, W. L. Imhof, and R. V. Smith (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 178-82(Jan. 1963).

An instrument designed to measure fluxes and energy distributions of protons in the range 10 to 100 Mev is discussed, together with related electronics. The instrument consists of a collimation housing containing two cesium iodide crystals and a plastic scintillator anti-coincidence ring. The electronics requires coincidence between the two CsI crystals and anti-coincidence with the plastic ring. The light from the large CsI crystal and the plastic anti-coincidence ring around it is sensed with a single photomultiplier tube and separated electronically by a phoswich circuit potted in the container with the tube. The coincidence, anti-coincidence output from the larger of the two CsI crystals is pulse-height analyzed by a 16 channel analyzer with binary coded output. Single count rates from each crystal are also telemetered by logarithmic count rate meters. The entrance port of the instrument contains a pair of magnets situated to minimize the count rate in the front CsI crystal from an electron flux. An instrument designed to measure electron fluxes and energy distributions in the energy range 50 to 1000 kev is also discussed. This instrument consists of a phototube and plastic scintillator housed in a collimated shield. The output is pulse-height analyzed by a sixteen-channel analyzer similar to the one used with the proton instrument. (auth)

16894 INSTRUMENTATION FOR NUCLEAR ANALYSIS OF THE LUNAR SURFACE. Ralph Monaghan, A. H. Youmans, R. A. Bergan, and E. C. Hopkinson (Dresser Research, Tulsa, Okla.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 183-9(Jan. 1963).

The surface of the moon can be analyzed by nuclear

methods, particularly fast-neutron activation, by means of a pulsed miniature neutron generator. Information can be derived from the activation gamma spectrum, capture radiation, neutron moderation times, natural gamma rays, and gamma rays scattered from a gamma source. (auth)

16895 ADVANCES IN SEMICONDUCTOR DETECTORS FOR CHARGED PARTICLE SPACE SPECTROMETRY. S. S. Friedland, H. S. Katzenstein, and F. P. Ziemba (Solid State Radiations, Inc., Los Angeles). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 190-201(Jan. 1963).

Nuclear semiconductor detectors are limited in their dynamic range of linearity of pulse height versus energy for charged particle spectrometry because of the depth of the sensitive volume, the thickness of any entrance window, and the noise level of the detector-amplifier system. Consideration is given to extending the range of sensitivity by increasing the volume of the detector by lithium-ion drift compensation, and to increasing the sensitivity to lower energies by removing any entrance window and reducing the noise level of the detector and the amplifier. (auth)

16896 EVALUATION AND VACUUM STABILITY TESTS OF SILICON RADIATION DETECTORS. W. L. Weiss (Oak Ridge Technical Enterprises Corp., Tenn.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 202-10(Jan. 1963).

Tests are carried out on silicon radiation detectors of both diffused-junction and surface-barrier types. Measurements are made of reverse current and rms noise level as a function of applied bias voltage in air and vacuum, alpha particle pulse height and energy resolution, and thickness of the sensitive surface dead layer. Long-term stability is evaluated for samples in air and in vacuum by periodic measurements of reverse current, rms noise voltage, and pulse height and energy resolution for 5.8-Mev alpha particles. The samples in the vacuum tests are maintained at rated bias voltage and a pressure of approximately 10^{-6} Torr continuously for a period of six months. Only minor changes are observed in the performance characteristics of the devices. (auth)

16897 SOFT PARTICLE DETECTORS. P. C. Fisher, A. J. Meyerott, H. A. Grench, R. A. Nobles, and J. B. Reagan (Lockheed Missiles and Space Co., Palo Alto, Calif.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 211-19(Jan. 1963).

Gas-filled proportional counters for detection of photons in the 0.1 to 20 kev energy range are constructed. Photons harder than a few kev are detected by sealed-off counters having thin Be windows. Photons softer than a few kev are detected by thin-window flow counters. Both types of counters are specifically constructed for an attempt to observe celestial sources of soft x rays. An instrument for alternately measuring electrons and protons having energies in the 0.1 to 20 kev energy range is also constructed. Energy analysis is accomplished in an electrostatic field, which deflects accepted particles by 90°. Bare electrostatic electron multipliers are used for particle detection. Inclusion of two multipliers, with quite different geometric factors, allows observation of a flux whose differential energy spectra varies rapidly with particle energy. In particular, the instrument is designed to measure steep auroral-electron spectra. (auth)

16898 PRODUCTION OF THICK SEMICONDUCTOR RADIATION DETECTORS BY LITHIUM DRIFTING. G. L. Miller, B. D. Pate, and S. Wagner (Brookhaven National Lab., Upton, N. Y.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 220-9(Jan. 1963). (BNL-6469)

The application of semiconductor junction radiation detectors to penetrating radiation depends on the production of devices having thick depletion layers. In this connection the lithium drift technique can be employed with success. A difficulty encountered with this method is the long time required to produce compensated regions a few millimeters or more in thickness. However, it can be shown that the compensated region produced by drifting at constant temperature is proportional to the cube root of the total energy dissipated in the drifting process. This finding indicates the importance of operating at the highest attainable power at all times, and leads to the design of a system employing a fluorocarbon liquid as a vapor-phase coolant in conjunction with a pulsed constant-wattage supply. High drift rates are achieved with this technique, which has the advantage of being suited to the simultaneous drifting of a number of detectors at constant power from a single power supply. (auth)

16899 GROUND BASED HIGH ALTITUDE DETECTION SYSTEMS. Cabell A. Pearse (Naval Research Lab., Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 236-41(Jan. 1963).

Methods for detecting nuclear explosions at about one-fourth earth-moon distances by means of ground-based detection systems are discussed. At such distances the detectable signals conveniently divide into direct signals originating in the explosion vicinity, and indirect signals arising in the ionosphere as a result of absorption of so-called thermal x rays from the incandescent nuclear device. Several different detection systems are discussed from the point of view of the signal-producing mechanisms and the natural background signals with which they must compete. It is found that there are at least five different detection methods available for detecting a 10 kt test at this range that could be integrated to become a high-altitude detection station. (auth)

16900 DETECTION OF HIGH ALTITUDE NUCLEAR DETONATIONS USING THE VLF PHASE SHIFT TECHNIQUE. A. G. Jean and D. D. Crombie (National Bureau of Standards, Boulder, Colo.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 242-53(Jan. 1963).

High-altitude nuclear detonations can affect the ionization of the lower ionosphere through a number of mechanisms. Three of the mechanisms, in their order of occurrence and in order of increasing time of onset are: prompt effect created by the prompt x rays, gamma rays, and neutrons from the bomb; neutron-beta decay effects; and delayed debris effects from gammas or betas radiated from the debris cloud in the region of the burst. In the first two cases the ionization decays (seconds to minutes) but in the last case the effect may persist for several days. In all cases, the distribution of ionization with height differs from the distribution produced by the sun, and it is a matter of some importance to relate this new distribution to changes in the "effective height" of the ionosphere. The minimum significant change in the height of the ionosphere depends on the signal-to-noise ratio of the received signal and the variations in ionospheric height that occur in the absence of nuclear explosions. Changes in the "effective height" of the ionosphere, under quiet conditions, of about 1 km are easily observed with equipment having a response time of about 1 second. In this case, and when faster response times are used, atmospheric noise sets the limit to sensitivity. When the speed of response is de-

creased, much smaller height changes having longer durations should be detectable, with the sensitivity being proportional to $\sqrt{T}$, where T is the response time. Under these conditions, the random height changes from natural causes are the limiting factor. It is concluded then that the detection of prompt effects requires apparatus having different characteristics from those required for the observation of effects of nuclear debris, the equipment characteristic for detection of neutron-decay ionization being intermediate. (auth)

16901 GROUND BASED DETECTION OF ATOMIC WEAPONS. S. D. Abercrombie (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 254-72 (Jan. 1963).

A description is given of work in the detection of atomic weapons. A brief review is given of various types of detection problems. Three examples taken in detail, namely vlf phase anomaly, telluric currents, and upper atmosphere fluorescence. The results using these three methods of detection are presented. (auth)

16902 DETECTION OF DEBRIS FROM ATMOSPHERIC TESTS. Lester Machta (U. S. Weather Bureau, Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 273-8(Jan. 1963).

The airplane, rocket, and balloon detection of radioactivity from nuclear explosions is discussed. It is assumed that other means are available for rapid approximation of the location, time, and altitude of the suspected explosion. The reliability of methods for altitudes less than or more than 70,000 ft, and for large and small explosions, are outlined. Possible methods of concealing nuclear explosions are noted, and the risks involved in these methods are shown. It is concluded that the atmosphere favors the detection of the explosion, unless it occurs at high altitudes. (T.F.H.)

16903 TEST DETECTION BY NUCLEAR CHEMISTRY. M. I. Kalkstein (Air Force Cambridge Research Labs., Bedford, Mass.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 279-84(Jan. 1963).

Radiochemical capabilities permit the detection of nuclear tests, to less than 1 kt of fission yield, in a large fraction of the earth's atmosphere. In almost any region of the atmosphere, it should be possible to detect megaton-yield tests, and the sensitivity for detection of the more remote tests will improve as recoverable rocket-borne samplers are developed. Radiochemical techniques should also be of assistance in the case of on-site inspection for underground nuclear tests. (auth)

16904 THE MICROBAROGRAPHIC DETECTION OF NUCLEAR EXPLOSIONS. William L. Donn, David M. Shaw, and Arthur C. Hubbard (Columbia Univ., New York). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 285-96(Jan. 1963).

In order to study the atmospheric pressure perturbations produced by the passages of gravity and acoustic-gravity waves through the atmosphere, a sensitive rate of change instrument (microbarovariograph) is developed. This instrumentation proves capable of recording the pressure variations from nuclear explosions in the megaton range, for distances that depend on the magnitude and elevation of the initial explosion. The pressure transducer developed is a U-tube manometer using a stable liquid plasticizer, dioctyl sebacate, of very low thermal expansion, vapor pressure, and creep. One side of the system is connected to a fixed insulated air reservoir or compliant volume. An adjustable leak in parallel controls the long-period time constants. Fluctuations of the liquid level in the open end are sensed by a moving coil in a differential transformer whose 60-cycle output is directly proportional in magnitude to the level changes, provided such changes are small. The signal, amplified and demodulated, gives a sensitivity of about 0.030 millibars (30 dynes per cm^2) per cm of scale deflection for a step displacement. A d-c post amplifier can give a sensitivity of about 0.001 millibars (1 dyne per cm^2) per cm of scale deflection. At the higher sensitivity, special hydraulic filtering procedures must be employed on the transducer in order to reduce atmospheric noise. Broadband recording is best accomplished at the lower sensitivity. A rather narrow pass-band filter is usually necessary at the higher sensitivity. Much of the data is recorded on a global network of pressure transducers supported by data from long-period seismographs, either uncompensated or partially compensated for atmospheric pressure changes. A summary of data recorded since the nuclear megaton explosions in 1952 is given. Interpretations of all data are given for the parameters of pressure amplitudes, yields (as far as known), and distances. A discussion is also given of the variations of signal-to-noise ratios. From the data studied, it is concluded that only nuclear explosions with yields greater than a megaton can be resolved above noise level at operational distances, although explosions in kiloton range can be detected at relatively short distances (2500 km) when background noise is low. (auth)

16905 SEISMIC DETECTION METHODS FOR UNDERGROUND EXPLOSIONS. Carl Romney (Air Force Technical Applications Center, Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 297-304 (Jan. 1963).

Underground explosions are detectable at long ranges only by recording and analyzing seismic waves. The signals received are highly distorted as a result of multi-path propagation, dispersion, mode conversion, and scattering. The result is that signals from explosions tend to be similar to those recorded from thousands of small earthquakes that occur each year. The basic detection problem thus becomes one of sorting out suspicious events from the many natural events recorded. No way of identifying explosions by seismic means is known, but methods of identifying a fair proportion of natural events exist and are being improved. The remaining occurrences in the suspicious category could be identified only if other kinds of information were available. (auth)

16906 ON-SITE INSPECTION FOR UNDERGROUND NUCLEAR TESTS. Charles C. Bates and Theodore F. George (Advanced Research Projects Agency, Washington, D. C.). IEEE (Inst. Elec. Electron. Engrs.) Trans. Nucl. Sci., NS-10: 305-10(Jan. 1963).

A review is given of the status in late 1962 of the VELA UNIFORM effort for developing and testing on-site inspection techniques. Of the techniques tested to date, it is tentatively concluded that ten have utility under the conditions existing at the GNOME event in southeastern New Mexico and at the Nevada Test Site locale of the NOUGAT-STORAX underground nuclear explosion series. Promising techniques include visual and photographic reconnaissance, changes in solid-state characteristics of certain minerals, gamma surveys, and after-shock monitoring. Problems exist with respect to deeply buried explosions, polar areas, and regions of shallow water cover. (auth)

16907 OPERATOR TECHNIQUES IN ATOMIC SPECTROSCOPY. Brian R. Judd. McGraw-Hill Advanced Phys-

ics Monograph Series. New York, McGraw-Hill Book Co., Inc., 1963. 249p. $9.95.

A treatment of the modern theory of atomic spectroscopy is presented from the standpoint of the experimentalist. The method of continuous groups developed by Racah is emphasized. The theory of fractional parentage and the applications of configurations of more than two equivalent electrons are discussed. (D.L.C.)

16908 NUCLEAR MASER. Arthur O. McCoubrey and Alexander Ganssen (to National Co., Inc.). U. S. Patent 3,080,519. Mar. 5, 1963. Filed July 20, 1959.

A maser utilizing stimulation of nuclear magnetic transitions is designed for efficient operation at frequencies in the region below 50 Mc. The maser uses the Overhauser effect to obtain a practical excess number of nuclei in the higher energy state. (D.L.C.)

16909 MASER SUPERCONDUCTIVE MAGNETIC FIELD PRODUCING MEANS. Peter F. Chester (to Westinghouse Electric Corp.). U. S. Patent 3,080,527. Mar. 5, 1963. Filed Jan. 30, 1959.

A microwave apparatus is described which is less heavy and bulky than previous masers. The apparatus includes a paramagnetic maser sample and a resonant chamber of superconductive material for locking in a magnetic field at low temperatures. (D.L.C.)

Astrophysics and Cosmology

16910 DENSITY OF NEUTRINOS AND ANTINEUTRINOS IN THE UNIVERSE. M. Gusakow (Faculté des Sciences, Paris). Ann. Phys. (Paris) (13), 7: 415-22(July-Aug. 1962). (In French)

In 1959 Pontecorvo, studying the consequences of the Fermi universal interaction theory, suggested that neutral leptons can be produced by processes other than nuclear reactions. Because of the low interaction of these particles with matter, the energy density existing in the universe in the form of neutrinos and antineutrinos can be very great. The few experimental data on neutral leptons are briefly reviewed. The actually known sources of neutral leptons and those which are hypothetical because they depend on the cosmological model adopted are cited. The actual knowledge on the density of neutrinos and antineutrinos comes from two sources—from the experimentally measured different interaction rates and from real knowledge of the universe by admitting a classical relativistic cosmology. These sources are discussed. The present and future possibilities for the measurement of the density of neutrinos and antineutrinos are described. (J.S.R.)

16911 MATTER-ANTIMATTER ANNIHILATION AND COSMOLOGY. Hannes Alfvén and Oskar Klein. Arkiv Fysik, 23: 187-94(1963). (In English)

The general symmetry between matter and antimatter, which has been confirmed through the discovery of the negative proton, requires that the universe should contain equal quantities of both. A theory of the development of the metagalactic system is discussed. The system—which is not identified with the whole universe—is thought to have originated as a sphere of very dilute plasma containing equal quantities of matter and antimatter. The sphere contracted due to gravitation but when the density reached a critical value ($\sim 10^{-2}$ atoms cm^{-3}) the annihilation became important. Thereby the inward motion was stopped and converted into the present outward motion connected with the redshift of the galaxies. An electromagnetic process is considered by which the matter-antimatter plasma was electrolyzed so that clouds of separated matter and antimatter were produced. It is pointed out that a cloud of matter repels a cloud of antimatter due to a Leidenfrost phenomenon. The theory leads to the conclusion that even today there must be equal quantities of matter and antimatter in our metagalaxy. The question is raised whether our own galaxy may contain antimatter. (auth)

16912 CATALOG OF TYPE II (SLOW-DRIFT) AND TYPE IV (CONTINUUM) SOLAR RADIO BURSTS. A. Maxwell, M. P. Hughes, and A. R. Thompson (Harvard Radio Astronomy Station, Fort Davis, Tex.). J. Geophys. Res., 68: 1347-54(Mar. 1, 1963).

Complete lists are given of solar radio bursts of spectral types II (slow-drift) and IV (continuum) recorded at Fort Davis, Texas, over a five-year period beginning January 1, 1957. These radio bursts are generally accompanied by flares of considerable importance and often precede large-scale geophysical phenomena. (auth)

16913 SOME CONSEQUENCES OF NONUNIFORMITY OF SOLAR WIND VELOCITY. Vikram Sarabhai (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 68: 1555-7(Mar. 1, 1963). (TID-17961; TID-16483)

Conditions in interplanetary space along the solar equatorial plane are examined for the radial velocity of the solar wind as a function of solar longitude. Consequences of the growth and decay of regions of activity and enhanced wind velocity as a function of time are considered. The resulting two-dimensional model has attractive features relevant to the interpretation of several observed cosmic-ray time variations. (C.E.S.)

16914 DISCUSSION OF PAPER BY L. M. NOBLE AND F. L. SCARF, 'HYDRODYNAMIC MODELS OF THE SOLAR CORONA'. E. N. Parker (Univ. of Chicago). J. Geophys. Res., 68: 1769(Mar. 15, 1963).

Some of the physical interpretations suggested in the paper "Hydrodynamic Models of the Solar Corona," Nobel, L. M. and Scarf, F. L., J. Geophys. Res., 67, 4577-4584, 1962, NSA 17: 5169, were shown to be in error. (C.E.S.)

16915 A NOTE ON INTERSTELLAR POLARIZATION BY GRAPHITE FLAKES. N. C. Wickramasinghe (Trinity Coll., Cambridge, Eng.). Monthly Notices Roy. Astron. Soc., 125: 87-92(1962).

The Cayrel-Schatzman theory of interstellar polarization by graphite flakes was re-examined in the light of more recent data concerning the electric and magnetic properties of graphite. Taking account of the highly anisotropic electric conductivity of graphite it is shown that the grains need be aligned only to a slight extent, about 2 per cent, in order to explain the observed polarization. The necessary alignment is shown to be accomplished by a galactic magnetic field of order 10^{-6} gauss. (auth)

16916 AN ASTROPHYSICAL APPLICATION OF THE 7.20(4+) Mev STATE OF ^{20}Ne. H. L. Duorah and R. S. Kushwaha (Univ. of Delhi). Nuovo Cimento (10), 27: 530-1(Jan. 16, 1963). (In English)

The formation of Ne^{20} through $O^{16}(\alpha,\gamma)Ne^{20}$ reaction due to its resonance levels was investigated. The cross section for α additions in Ne^{20}, Mg^{24}, Si^{28}, S^{32}, Ar^{36}, and Ca^{40} are calculated as averaged over many resonances. In a time of the order available in supernova explosive phases, considerable amounts of Ne^{20} can be produced if the supply of α particles is abundant. (C.E.S.)

16917 NEUTRINO AND ITS ROLE IN ASTROPHYSICS. Bruno Pontecorvo. Usp. Fiz. Nauk, 79: 3-21(Jan. 1963). (In Russian)

The properties of the neutrino and its penetrating ability in the cosmos were surveyed. In heavy ($Z \sim 12$) stars with high temperatures ($T > 10$ kev) and densities ($\rho > 3 \times 10^3$ g/cm^3) the luminosity of neutrinos exceeds that of photons. The stars emit neutrino-antineutrino pairs due to various mechanisms (neutrino bremsstrahlung, photoneutrino effects, and neutrino annihilation of positrons and electrons) combined with neutrino interactions with electrons of the first order according to the weak interaction constant. It is postulated that neutrinos and antineutrinos actively participate in white dwarf evolution and supernova explosion dynamics and are of great importance in cosmology. (R.V.J.)

Cosmic Radiation

16918 (UCRL-10587) EAST-WEST ASYMMETRY IN THE FLUX OF MIRRORING GEOMAGNETICALLY TRAPPED PROTONS. Harry H. Heckman (California. Univ., Berkeley. Lawrence Radiation Lab.) and George H. Nakano (Lockheed Missiles and Space Co., Palo Alto, Calif.). Dec. 13, 1962. Contract W-7405-Eng-48. 15p.

The visual detection of geomagnetically trapped protons in the region of the South Atlantic magnetic anomaly is reported. Protons of energy ≥57 Mev were recorded in nuclear emulsions during a 65 orbit, oriented flight of a satellite recovered on September 1, 1962. An east-west asymmetry in the flux of geomagnetically trapped protons is observed, confirming an effect predicted by Lenchek and Singer. From measurements of the east-west asymmetry, a value of 62.0 ± 5.0 km for the scale height of the atmosphere at 364 km altitude is obtained. (auth)

16919 ANALYSIS OF THE INTEGRAL SPECTRUM OF IONIZATION PULSES CAUSED BY NUCLEAR ACTIVE PARTICLES AT MOUNTAIN ALTITUDES. J. Łoskiewicz, J. Massalski, B. Niziol, and A. Oleś (Inst. of Nuclear Research, Polish Academy of Sciences, Krakow). Acta Phys. Polon., 23: 77-92(Jan. 1963). (In English)

A measurement of energy spectrum of nuclear active particles near sea level (200 m) and at mountain altitudes (3200 m) was undertaken. The apparatus consisted of ionization chamber trays and mixed lead-graphite absorbers. The spectrum found is almost exponential. The slope has a slight increasing tendency at high energies, but at present without statistical significance. The exponent of the spectrum in energy range $10^{12}-5 \times 10^{13}$ ev is at mountain altitudes 1.7 ± 0.1. It has the same value as primary spectrum exponent in energy interval $10^{12}-10^{15}$ ev. This means that the total inelasticity coefficient is energy independent. (auth)

16920 INTENSITY OF ELECTRONS IN THE EARTH'S INNER RADIATION ZONE. L. A. Frank and J. A. Van Allen (Univ. of Iowa, Iowa City). J. Geophys. Res., 68: 1203-7(Mar. 1, 1963).

The intensities of electrons as measured with the SUI satellite Injun 1 during its deepest penetrations into the earth's inner radiation zone are reported for the period July 16 to August 10, 1961. The unidirectional intensity of electrons of energy greater than 40 kev was 5×10^6 electrons/cm^2 sec ster in a direction perpendicular to B at L = 1.22 in the magnetic equatorial plane. The corresponding omnidirectional intensity is estimated to be 1×10^7/cm^2 sec. No temporal variations greater than the experimental uncertainty of 30 per cent were found in this region during the period of observation of this report. (auth)

16921 MOTIONS OF CHARGED PARTICLES TRAPPED IN THE EARTH'S MAGNETOSPHERE. Edward W. Hones, Jr. (Inst. for Defense Analyses, Washington, D. C.). J. Geophys. Res., 68: 1209-19(Mar. 1, 1963).

Recent measurements by earth satellites provide conclusive evidence that the magnetosphere of the earth is distorted by the solar wind, as was predicted on theoretical grounds for some time. Motions of charged particles trapped in the distorted magnetosphere were computed by using, as a model of the magnetosphere, the field of a weak magnetic dipole in the presence of a strong magnetic dipole. Drift paths through this field were calculated both for particles whose motion is confined to the magnetic equatorial plane and for particles mirroring at low altitudes. The paths of particles of various energies moving in the magnetic equatorial plane under the combined influences of field gradient-induced drift and field rotation were also calculated. It was found that, in the model used, the field rotation energizes trapped particles on the morning side and de-energizes them on the evening side of the earth. It is suggested that this effect must occur in any realistic model of the distorted magnetosphere and that it may play a role in the accumulation of the energetic particles that constitute the Van Allen zones. (auth)

16922 NEUTRON FLUX AND ENERGY SPECTRUM ABOVE THE ATMOSPHERE. S. J. Bame (Los Alamos Scientific Lab., N. Mex.), J. P. Conner, F. B. Brumley, R. L. Hostetler, and A. C. Green. J. Geophys. Res., 68: 1221-8(Mar. 1, 1963). (LADC-5456)

Neutron detectors consisting of $B^{10}F_3$ proportional counters and Li^6I(Eu) scintillation counters, surrounded by varying amounts of moderating material, were flown above the atmosphere in a number of vehicles. The shape of the neutron energy spectrum given by Hess, Canfield, and Lingenfelter has been verified within experimental limitations, and the flux of neutrons at 650-km altitude and 36.5°N geomagnetic latitude has been determined to be 0.28 ± 30 per cent neutrons per cm^2 sec, whereas at 320-km altitude and 8.7°S the flux is 0.12 ± 40 per cent neutrons per cm^2 sec. This flux determination gives an absolute neutron flux a factor of 3 lower than previously reported determinations. (auth)

16923 COMMENT ON A PAPER BY DAVID STERN, "COSMIC-RAY VARIATIONS DURING IGY." V. D. Hopper (Univ. of Melbourne). J. Geophys. Res., 68: 1558(Mar. 1, 1963).

The relation between equivalent amplitude of 27-day variation with modified cutoff regidity is shown. Amplitudes and equivalent amplitudes are also given. (C.E.S.)

16924 ABSOLUTE INTENSITIES OF GEOMAGNETICALLY TRAPPED PARTICLES WITH EXPLORER 14. L. A. Frank, J. A. Van Allen, W. A. Whelpley, and J. D. Craven (State Univ. of Iowa, Iowa City). J. Geophys. Res., 68: 1573-9(Mar. 15, 1963).

A new series of observations on the absolute intensities of geomagnetically trapped protons and electrons in the earth's outer radiation zone and on the nature of the outer boundary of the magnetosphere were reported. The equipment was carried on the NASA satellite Explorer 14, which was launched on October 2, 1962, into an eccentric orbit whose apogee was initially at 16.5 earth radii from the center of the earth on a line at 71° to the line from the center of the earth to the sun. Sample omnidirectional intensities of electrons on October 5, 1962, near the magnetic equatorial plane were given for a geocentric radial distance of 39,000 km; and of electrons and protons at a

geocentric radial distance of 20,000 km. There are large fluctuations from day to day. (auth)

16925 ASYMMETRIES IN THE FORBUSH DECREASES OF THE COSMIC RADIATION. 1. DIFFERENCES IN ONSET TIMES. J. A. Lockwood and H. Razdan (Univ. of New Hampshire, Durham). J. Geophys. Res., 68: 1581-91(Mar. 15, 1963).

The cosmic-ray neutron intensity at a large number of stations was analyzed to determine the differences in onset times of the large Forbush decreases occurring from 1957 to 1961. From the directional response characteristics of the neutron detectors, these differences in onset times are related to directions in space beyond the geomagnetic field. It is observed that the onset of the Forbush decrease was always earlier from west of the earth-sun line, regardless of the location on the sun of the solar flare, which was the source of the plasma cloud causing the decrease. The onset differences from the directions west and east of the earth-sun line varied from the order of minutes to a few hours. For Forbush decreases whose onset at some stations occurred before the sudden commencement of a magnetic storm, the solar plasma cloud responsible for the decrease generally originated from the western hemisphere of the solar disk. The stations recording the earlier decrease were, in general, sampling particles from west of the earth-sun line at the time of the decrease. These results are explained in terms of the configuration of the solar plasma cloud, and conclusions are drawn about the plasma velocity and the magnitude of the associated magnetic field. (auth)

16926 ASYMMETRIES IN THE FORBUSH DECREASES OF THE COSMIC RADIATION. 2. SUPERIMPOSED INTENSITY VARIATIONS DURING A FORBUSH DECREASE. J. A. Lockwood and H. Razdan (Univ. of New Hampshire, Durham). J. Geophys. Res., 68: 1593-1604(Mar. 15, 1963).

Intensity increases or decreases, which are sometimes a strong function of longitude, are frequently found superimposed on the normal behavior of the cosmic-ray intensity during Forbush decreases. A study was made of these effects utilizing the neutron monitor data from many stations distributed in latitude and longitude. The anisotropies recorded as decreased intensities occurred from the west, and those recorded as increases occurred from the east, of the earth-sun line. These anisotropies were both long and short lived. The long-lived anisotropies shifted westward as time progressed. Besides the anisotropies, superimposed intensity increases occurred at all stations at the same universal time, the magnitudes of which were larger at stations sampling particles from directions east of the earth-sun line at the time of the increase. A qualitative explanation of these observed effects is given in terms of the configuration and the possible instabilities of the plasma cloud. (auth)

16927 EXPONENTIAL RIGIDITY SPECTRUMS FOR SOLAR-FLARE COSMIC RAYS. P. S. Freier and W. R. Webber (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 68: 1605-29(Mar. 15, 1963).

A study of solar proton spectra in the range from a few Mev to a few Bev reveals that the number spectra of these particles near the earth may be represented by an exponential rigidity spectrum of the form $J = J_0 e^{-P/P_0}$. Such a spectral representation also applies to α particles. The rigidity, P, is the momentum per unit charge. Intensity-time characteristics of the solar protons are examined, and it is significant that propagation changes P_0 and J_0 but not the exponential nature of the spectrum. Changes in the intensity and spectrum of the solar protons are investigated at times of magnetic storms. The features of these changes are discussed, and certain relations between the low-energy plasma producing the magnetic storm and the high-energy solar proton plasma are pointed out. As a result of the observations of exponential rigidity spectra for solar protons and α particles observed at the earth and features of the continuum solar radio emission at the times of flares, a consistent understanding of the acceleration and propagation of the solar protons is obtained if one assumes that a very rapid accelerating mechanism exists (about 1 minute or less) and that this mechanism accelerates particles of different ze/m, producing similar rigidity spectra. These exponential spectra are then maintained, in general, throughout the propagation of the particles in the interplanetary medium. (auth)

16928 ACCIDENTALLY RESONANT ASYMMETRIC CHARGE EXCHANGE IN THE PROTONOSPHERE. Donald Rapp (Lockheed Missiles and Space Co., Palo Alto, Calif.). J. Geophys. Res., 68: 1773-5(Mar. 15, 1963).

The effect of the cross section of the nearly resonant asymmetric charge exchange process on the properties of the protonosphere is discussed. For a cross section of the order of 10^{-15} cm^2 charge exchange is the main source of protons. If the cross section is of the order of 10^{-18} cm^2, photoionization of hydrogen might be the dominant means of the production of protons. It is concluded that the cross section for the process in the ionosphere is almost surely greater than 2×10^{-16} cm^2, and more probably 2×10^{-15} cm^2. Therefore charge exchange must be the dominant source of protons in the ionosphere. (C.E.S.)

16929 THE ENERGY DISTRIBUTION BELOW 1 Gev/NUCLEON OF THE MULTIPLY CHARGED PARTICLES OF THE COSMIC RAYS. D. E. Evans (Univ. of Bristol, Eng.). Nuovo Cimento (10), 27: 394-417(Jan. 16, 1963). (In English)

The energy spectrum above 200 Mev/nucleon of the heavy ($Z \geq 3$) nuclei of the cosmic radiation was measured in a stack of emulsions flown on the 18th of September, 1956, at geomagnetic latitude 55°N, and at an atmospheric depth of 6.7 g · cm^{-2}. The total fluxes observed were $J_L(0) = 4.4 \pm 0.8$, $J_M(0) = 17.6 \pm 2.3$, and $J_H(0) = 7.3 \pm 1.1$ particles m^{-2}s^{-1}sr^{-1} for the light, medium, and heavy nuclei respectively. The energy spectrum of each component exhibited a peak at about 350 Mev/nucleon, and above about 700 Mev/nucleon the spectra were consistent with the usual power law with an exponent $\gamma = 2.5$. By comparison with the results of other experiments performed under different conditions of solar activity, it is shown that the $Z \geq 3$ particle component undergoes a variation in intensity correlated with that of the ambient cosmic ray activity recorded by neutron monitors, that a feature of the variation is the stability of the chemical composition of the heavy primary cosmic rays (with the possible exception of the light nuclei), and that the changes of intensity of the $Z \geq 3$ component come about chiefly, but not exclusively, through the preferential removal of low energy particles, resulting in a shift of the peak toward higher energies as the flux decreases. (auth)

16930 SPECTRAL VARIATION OF PRIMARY COSMIC RAYS DURING FORBUSH DECREASES. F. Bachelet, P. Balata, and N. Iucci (Università, Rome and Istituto Nazionale di Fisica Nucleare, Rome). Nuovo Cimento (10), 27: 425-40(Jan. 16, 1963). (In English)

Variations of primary cosmic ray rigidity spectrum occurring at typical Forbush decreases in the geomagneti-

cally sensitive range are studied. Selected events are grouped in two classes according to the degree of associated geomagnetic perturbation. It is shown that the systematic differences between the two classes, arising when spectral variation is derived from the latitude effect of the amplitude of nucleonic intensity decrease, do practically vanish when tests independent of any variation on the geomagnetic field are applied. For events of the geomagnetically quiet group an inverse power law $\delta D(R)/D(R) = -BR^{-k}$ with an exponent k lower than unity is found to approximate well all the analyzed experimental data. (auth)

16931 ENERGY SPECTRUM OF VARIATIONS OF COSMIC-RAY DAILY MEAN INTENSITY RECORDED DURING THE I.G.Y. R. P. Kane (Physical Research Lab., Ahmedabad, India). Nuovo Cimento (10), 27: 441-67 (Jan. 16, 1963). (In English)

Using Quenby and Wenk's revised vertical cut-off rigidities and Webber and Quenby's coupling constants, data for neutron monitors, cubical meson telescopes and ionization chambers from several stations are analyzed to determine the energy spectrum of all the major decreases and increases of the daily mean intensity of cosmic rays during I.G.Y. A spectrum of type $A \cdot E^{-\nu}$ where ν ranges from 0.2 to 0.8 fits every event satisfactorily, provided the upper limit of energy is allowed to be as low as 50 Bev. Still lower values are not ruled out and could be compatible with $\nu = 0$ in every case. Compatibility with various models invoked for explaining such changes is discussed. (auth)

16932 ENERGY SPECTRUM OF HEAVY NUCLEI OF THE PRIMARY COSMIC RADIATION DURING SOLAR MAXIMUM. K. A. Neelakantan and P. G. Shukla (Tata Inst. of Fundamental Research, Bombay). Phys. Rev., 130: 362-8(Apr. 1, 1963).

The energy spectrum of nuclei with $Z \geq 13$ was determined using the knock-on electron method in a stack of nuclear emulsions flown on 4 February 1959 from Texas, U. S. A. ($\lambda = 41°N$). In the interval of kinetic energy from 1.5 to 10 Bev/nucleon, the exponents of the integral energy spectra for nuclei with charge $Z \geq 13$, $13 \leq Z \leq 16$ and for those with $Z \geq 17$ were determined to be 1.70 ± 0.30, $1.85^{+0.23}_{-0.20}$, and $1.55^{+0.20}_{-0.30}$, respectively. From this and other similar experiments it is surmised that within the experimental uncertainties the observations are consistent with the assumption that the energy spectra of all the components of the primary cosmic radiation have the same exponent; also the exponent seems to be the same during solar minimum and during solar maximum. The flux of nuclei with $Z \geq 10$ was obtained as 1.26 ± 0.09 particles/m^2 sec sr and that of nuclei with $Z \geq 20$ as 0.39 ± 0.06 particle/m^2 sec sr. These values are ~50% lower than those determined over Texas during solar minimum. (auth)

16933 MEASUREMENTS OF ATMOSPHERIC SLOW NEUTRONS IN THE PACIFIC AND THE INDIAN OCEAN. Yukio Miyazaki, Masahiro Kodama, Hidehiro Suda, and Koichi Kamata. Rika Gaku Kenkyusho Hokoku, 38: 497-505 (1962). (In Japanese)

16934 LARGE IONIZATION BURSTS AND THE SPECTRUM OF NUCLEAR-ACTIVE PARTICLES AT MOUNTAIN HEIGHTS. Kh. P. Babayan, N. G. Boyazhan, N. L. Grigorov, Ch. A. Tretyakova, and V. Ya. Shetoperov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 22-34(Jan. 1963). (In Russian)

Large ionization bursts were studied with an arrangement covering an area of $10m^2$ and containing 192 ionization chambers. An analysis of the data obtained shows that a significant part of the large ionization bursts are due to several nuclear-active particles simultaneously striking the apparatus. Simultaneous incidence of the particles is the reason that for bursts recorded over an area of 10 m^2 the power exponent of the integral burst spectrum is $\gamma = 1.38 \pm 0.03$, whereas the exponent of the burst spectrum for separate particles is $\gamma = 1.92 \pm 0.05$. (auth)

16935 DETERMINATION OF FLUCTUATIONS OF THE NUMBER OF PARTICLES IN AN ELECTRON-PHOTON SHOWER BY TAKING INTO ACCOUNT IONIZATION LOSSES. N. M. Gerasimova (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 44: 240-3(Jan. 1963). (In Russian)

Expressions for the mean squares of the number of particles in an electron-photon shower are obtained in analytic form by taking into account ionization losses. Plots of the ratios of the mean square number of particles to the square of the mean number as a function of depth are presented for various primary electron and photon energies and various secondary particle energies. (auth)

16936 COSMIC RAYS. A. W. Wolfendale. New York, Philosophical Library Inc., 1963. 229p. $10.00.

This book is an introduction to the subject of cosmic rays for students at undergraduate level and scientists working in other fields. The interactions and detection of the cosmic rays are considered. Cosmic rays in the atmosphere, at sea level, and underground are discussed. A short chapter is given on the radiation belts. (D.L.C.)

16937 A STUDY OF THE OUTER ZONE OF THE VAN ALLEN TRAPPED RADIATION DURING AUGUST AND SEPTEMBER, 1959. Roger Lee Arnoldy. Thesis, Minneapolis, Univ. of Minnesota, 1962. 210p.

Through an analysis of the data from radiation detectors aboard the Explorer VI earth satellite, a study is made of the outer zone of the earth's trapped radiation as it existed during August and September, 1959. An ionization chamber and Anton-type-302 Geiger counter were the detectors in the experiment. The data from a proportional counter telescope and a scintillator are correlated with the ion-chamber and Geiger-counter data. The energy spectrum of the trapped particles as a function of range from the earth and the time variations of the detector rates are investigated to provide a basis for understanding the source of the radiation and its association with other geophysical phenomena. The simultaneous measurement of an increase in radiation observed at a geocentric range of 42,000 km and the occurrence of a visual aurora on the electron shell connecting with the satellite measurements indicate that the aurora is associated with a disturbance extending over many degrees longitude and out to large ranges. Furthermore, the measurement of a rapid decrease in detector rates simultaneous with a strong low latitude aurora at Fargo, North Dakota, suggests that energetic radiation is either precipitated out of the trapping region during strong auroras or else decelerated by a disturbance associated with the auroras. Frequent observations of enhanced radiation at the outer edge of the trapping region and at apogee show the great instability of this region, resulting in the frequent precipitation of radiation into the atmosphere as observed by balloon borne detectors at the high latitudes connecting with the region. The close association of outer zone intensity variations and solar phenomena indicates that the energy involved in the dynamics of the trapped radiation has a solar origin. (M.P.G.)

16938 THE COSMIC RAY PION-MUON CASCADE AT HIGH ENERGIES. Ronald Robert Kasten. Thesis, Columbia, Mo., Univ. of Missouri, 1962. 185p.

The diffusion equation method of analysis was applied to the energetic cosmic ray pion flux throughout the earth's atmosphere, with special emphasis on realistic treatment of the geometry and other aspects of the atmosphere. The principle results are intensities of muons near the earth's surface as functions of energy, zenith angle, and assumed values of the pion-attenuation mean free path. The results indicate an increase in intensity with zenith angle for muons with energy near 40 Bev or greater. This reflects a decrease in the absorption of pions with increasing zenith angle. The theoretical calculations are in good agreement with experimental results. This comparison indicates that the pion-attenuation mean free path is nearer 120 gm/cm^2 than 60 gm/cm^2. The results also appear to indicate that kaons make no significant contribution to the muon flux between 30 and 200 Bev. Detailed calculations of average muon energies underground at various depths and zenith angles are also given. A comparison of muon intensities in a flat atmosphere and a spherical atmosphere is given. The results indicate that at moderate energies (~30 Bev) and large zenith angles the muon intensities in a flat atmosphere are too low, while for the same atmosphere at large energies (~120 Bev) and large zenith angles the muon intensities are too high. These features are explained in physical detail. Finally an exploratory calculation is presented to investigate the feasibility of measuring muon intensities high in the atmosphere to test for anomalous absorption of pions at low energies (~10 Bev). The results indicate that the muon intensity increases with zenith angle for energies lower than 10 Bev at atmospheric depth 100 gm/cm^2 but that anomalous pion absorption corresponding to abrupt changes from geometric mean free path to half this value would be difficult to observe experimentally in the zenith angle region 0°–60°. (Dissertation Abst., Vol 23, No. 7)

16939 SOLAR COSMIC RAYS. Frank B. McDonald (National Aeronautics and Space Administration, Greenbelt, Md.). Preprint Paper No. 63-3. New York, Institute of the Aerospace Sciences, 1963. 10p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Some of the pertinent properties of solar cosmic ray events are summarized. These include size vs frequency of occurrence, propagation characteristics, and charge and energy spectra. The November 12 and November 15, 1961, events are regarded as possibly typical of the great events and their complete time history is presented. (auth)

Criticality Studies

16940 (NAA-SR-7263) REFLECTED REACTOR KINETICS. R. W. Keaten and C. W. Griffin (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 1, 1963. Contract AT(11-1)-Gen-8. 21p.

The transfer function of a reflected reactor was derived from a model which is applicable to all reactors. The result is identical to a bare reactor transfer function at low frequencies, provided that the neutron lifetime includes the effect of the reflector. At high frequencies the reflector introduces in effect an additional group of delayed neutrons. A calculation of the effective neutron lifetime in the SRE from the theoretical results was in good agreement with the experimental value. (auth)

16941 (RFP-63) CRITICALITY MEASUREMENTS ON PLUTONIUM METAL PRELIMINARY TO THE DESIGN OF A MELTING CRUCIBLE. C. L. Schuske, M. G. Arthur, and D. F. Smith (Dow Chemical Co. Rocky Flats Plant, Denver). June 1, 1956. Contract AT(29-1)-1106. 12p.

A series of neutron multiplication measurements were made on assemblies of Pu metal (density 15.8 g/cm^3) in order that a safe melting crucible could be designed for charges of 10 kg or more. Suitable ingot shapes and masses that could be rolled into sheets were determined. Final charge limits must be determined by making in situ measurements with the actual production furnace when the furnace and crucible are completed. (H.G.G.)

16942 (TID-18064) PILE OSCILLATOR EXPERIMENTS WITH THE ADVANCED TEST REACTOR CRITICAL EXPERIMENTS. A. L. MacKinney (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). Nov. 1962. For Ebasco Services, Inc., New York. Contract AT(10-1)-1075. 34p. (ATRCE-104)

A rotary, self-shielding oscillator was used to excite the ATR Critical Experiment. The alternating component of the ion current was then demodulated and Fourier analyzed by a digital computer. The resulting analysis yielded the amplitude and phase relationship of the fundamental and the succeeding four harmonics, which could then be related to the pile transfer function. (auth)

Elementary Particles and Radiations

16943 (AE-101) SOLID ANGLE COMPUTATIONS FOR A CIRCULAR RADIATOR AND A CIRCULAR DETECTOR. J. Konijn and B. Tollander (Aktiebolaget Atomenergi, Stockholm). Feb. 1963. 22p.

The problem of particle detection, when using an isotropic neutron point source at different distances from a circular target or a radioactive source as seen by a circular detector, e.g. a solid state counter, is discussed. Tables are given for different distances of the source, when the reaction at the target has an isotropic or a cosine angular distribution in the laboratory system. (auth)

16944 (CERN-62-36) ETUDE DE LA TRANSMISSION PAR UN SYSTEME MAGNETIQUE LINEAIRE D'UN FAISCEAU DE PARTICULES PRIMAIRES ET DES SECONDAIRES EMIS EN VOL. PROGRAMME FORTRAN (CERN 06008 B 50). (Study of the Transmission Through a Linear Magnetic System of a Beam of Primary Particles and the Secondaries Emitted in Flight. Program FORTRAN (CERN 06008 B 50)). J. Fronteau and J. Hornsby (European Organization for Nuclear Research, Geneva). Nov. 25, 1962. 49p.

A program was written for the IBM-709 to study the transmission through a linear magnetic system of a beam of primary particles and the secondaries emitted in flight. An attempt was made to make a tool more rapid, more flexible, and more complete than those previously written. The beam guide, the three types of problems, the formulas utilized, and formulation of the data for the computer are discussed. In conclusion, some examples are given. (J.S.R.)

16945 (GAMD-1256) DIFFRACTION OF RADIATION AROUND AN OPAQUE DISC. W. G. Vulliet (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Feb. 18, 1960. Contract AF29(601)-2207. 7p.

An expression for the intensity ratio I_p/I_0, where I_0 is the radiation intensity at the edge of the disc and I_p is the

intensity at the point of interest, is derived for the diffraction of radiation by a disc lying between the source and the point. The expression shows that as the disc moves off the point-source axis the intensity goes through a series of diminishing maxima and that the intensity for a source-disc distance ≫ the disc radius the intensity of diffracted radiation on the disc's axis is the same as if there were no disc. As the disc is brought closer to the source, the intensity approaches zero. (D.C.W.)

16946 (ISS-62/15) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DEL MESONE η^0 CON MASSA DI 550 Mev. (Kinematics of the Photoproduction from Hydrogen of the η^0 Meson of 550 Mev Rest Mass). G. Cortellessa (Italy. Istituto Superiore di Sanità, Rome). Apr. 1962. 33p.

Kinematical tables for the photoproduction from protons of a neutron meson of 550 Mev rest mass were calculated for bombarding energies between 725 and 1500 Mev using the program A of the Report ISS–IT 60/5. (auth)

16947 (ISS-62/24) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 279.2 Mev. (Kinematics of the Photoproduction from Hydrogen of Particles of 279.2 Mev Effective Mass). G. Campos Venuti (Italy. Istituto Superiore di Sanità, Rome). July 1, 1962. 20p.

Kinematical tables of the photoproduction from protons of a particle of 279.2 Mev effective mass were calculated for bombarding energies between 350 and 6000 Mev. The calculation was made using the program A of the Report ISS-IT 60/5. (auth)

16948 (JINR-D-1128) ROZONANSNAYA MODE NN-VZAIMODEISTVII I EE PRILOZHENIE K YADRU. (Resonance Model of NN-Interactions and Its Application to Nuclei). V. V. Babikov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1962. 13p.

It is postulated that π-π interactions account for the high pion contribution to N-N potentials by means of single particle exchange in certain π-π resonances. Various types of resonance capable of contributing to the nuclear forces are analyzed. The importance of ω resonance was stressed, and a resonance model with two vector (I = 0 and I = 1) and one scalar (I = 0) resonance exchange was studied. Comparisons with T. Hamada et al. (Nucl. Phys., 34: 382(1962)) phenomenological N-N potentials are used in the evaluation of the resonance–nucleon bond constant. The obtained data are in agreement with Hamada–Johnston potentials. The application of a resonance model supplies an explanation for the semiempirical formula of nuclear mass. (R.V.J.)

16949 (JINR-E-1156) REGGE POLES AND FIRE BALLS. P. Surani (Suranyi) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 7p.

The behavior of the amplitude of inelastic processes is calculated assuming the existence of Regge poles. The asymptotic behavior of the cross section for the emission of n particles is shown to be $\sigma_n \approx Cn/[\log (s/s_0)]$. The two center emission of particles is found to give the largest contribution in the asymptotic region. (auth)

16950 (JINR-P-1135) UPRUGOE RASSEYANIE PROTONA NA PROTONE PRI ENERGII 8.35 Bev. (Elastic Proton-Proton Scattering at 8.35 Bev). Ying-seb To, L. F. Kirillova, and M. G. Shafranova (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1962. 9p.

A more accurate differential cross section for elastic p–p scattering at 8.35 Bev obtained by the emulsion technique is given. The work is a continuation of experiments made earlier to increase the statistical accuracy in the region of small angle scattering (<8.5° cms) and to get more reliable data in the range of large angles (>8.5° cms). It became clear that the cross section in the large angle region is greater than that obtained previously. The data are analyzed in the framework of the Regge poles and compared with other experiments. The total cross section for elastic p–p scattering was found to be (10.8 ± 0.8) mb, the root–mean–square radius to be $\sqrt{\overline{r^2}} = (1.07 \pm 0.08)$ f. (auth)

16951 (JINR-P-1150) OB UPRUGOM (π-π)-RASSEYANII PRI VYSOKIKH ENERGIYAKH. (On an Elastic (π-π)-Scattering at High Energies). V. I. Nikanorov (Joint Inst. for Nuclear Research Dubna, U.S.S.R. Lab. of Nuclear Problems). 1962. 4p.

Differential cross sections of elastic π-π scattering at $S_{\pi\pi}$ 2.0 and 14.4 Bev were calculated, and it is shown that at $S_{\pi\pi} = 2.0$ Bev the scattering is almost isotropic. The total cross section of π-π interaction, $\sigma_{tot} = 15$ mb, obtained by the optical theorem is in agreement with the data obtained by V. N. Gribov et al. (Zh. Exp. Teor. Fiz., 42: 1141(1962)). (R.V.J.)

16952 (JINR-P-1161) ZAPRESHCHENNYE KINFIGURATSII MEZONOV V MNOGOMEZONNYKH RASPADAKH. (Forbidden Meson Configurations in Multimeson Decay). G. I. Kopylov and V. I. Ogievetskii (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy and Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 30p.

The most general dynamic-independent symmetries of multi-pion systems with definite spin, parity, and isotopic spin are considered. The forbidden pion configurations resulting from these symmetries are obtained for systems consisting of four and three pions in states with spin 0,1, 2, isotopic spin 0,1 and parity ±1. This can be used to determine the quantum numbers of conceivable resonance systems decaying into pions by means of strong interactions. The results are listed. (auth)

16953 (JINR-P-1163) ROZHDENIE STRANNYKH CHASTITS. (Strange Particle Production). V. S. Barashenkov and I. Patera (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 30p.

The available experimental data on the cross sections for the production of K mesons and hyperons in N–N and π–N collisions by antinucleon annihilation were collected and analyzed theoretically. The tables and interpolation curves are given. 88 references. (auth)

16954 (NP-12644) PROPERTIES OF VERTEX FUNCTIONS IN STRONG INTERACTIONS (thesis). Sudesh Bose (Brandeis Univ., Waltham, Mass.). Jan. 1963. 77p.

Analytic properties of some vertex functions of strongly interacting particles are studied in order to obtain relations between the masses and the coupling constants. The vertex $\Sigma\Lambda\pi$ is studied for even $\Sigma\Lambda$ relative parity. A relationship between the masses of Σ, Λ, and π and the $\Sigma\Lambda\pi$ coupling constant is obtained. The techniques derived are applied to the vertices of $\Sigma\bar{K}N$ and $\Lambda\bar{K}N$. The value of the ratio of $\Lambda\bar{K}N$ and $\Sigma\bar{K}N$ coupling constants is obtained. Calculation of the isovector charge form factor of Σ-particle is performed. Only the two pion intermediate states are retained and the amplitude $\pi + \pi \rightarrow \Sigma + \bar{\Sigma}$ is approximated by a Λ-pole. By writing down an unsubtracted dispersion relation for the charge form factor for zero momentum transfer and by invoking the requirement of normalization at zero momentum transfer, another independent relation between the masses of Σ, Λ, and π and the $\Sigma\Lambda\pi$ coupling

constant is obtained. By combining this relation with a previously obtained relation, the values of the $\Sigma\Lambda\pi$ coupling constant and Σ-mass are calculated. The electromagnetic form factor of Σ is calculated by a technique suggested by Cutkosky. The value of anomalous magnetic moment of Σ is obtained. (auth)

16955 (NYO-10238) SOME CONSEQUENCES OF ANALYTICITY AND UNITARITY CONDITIONS IN SCATTERING PROBLEMS. [PART] II. Susumu Okubo (Rochester, N. Y. Univ.). July 5, 1962. Contract AT(30-1)-875. 15p.

Investigation of the consequences of analyticity and unitarity conditions, previously done for pion-pion scattering, has been extended to the cases of the pion-nucleon and nucleon-nucleon scattering problems. Especially, the generalized Froissart-Goebel theorem can be shown to hold valid for these cases. (auth)

16956 (NYO-10239) REGGE'S TRAJECTORY AND DOMAIN OF HOLOMORPHY. Susumu Okubo (Rochester, N. Y. Univ.). July 16, 1962. Contract AT(30-1)-875. 25p.

The analyticity domain of the scattering amplitude A(l,s) as a function of the complex angular momentum l and the complex energy variable s has been investigated on the basis of the Mandelstam representation and of the unitarity and reality conditions. The analyticity domain thus obtained has been proved to be a domain of holomorphy. It is possible to continue analytically with A(l,s) into the second and into the higher Rieman sheets where A(l,s) may have simple poles there. This Rieman manifold consists in general of infinitely many sheets, except for cases of integer l where only two sheets exist. In this connection, the low energy theorem for A(l,s) has been derived. 21 references. (auth)

16957 (ORNL-TM-514) SOME SIMPLIFIED EXPRESSIONS FOR THE 3-j SYMBOLS. C. D. Zerby and R. R. Coveyou (Oak Ridge National Lab., Tenn.). Mar. 15, 1963. Contract [W-7405-Eng-26], 9p.

A general formalism is developed for obtaining simplified expressions for the 3-j symbol using the symmetry properties of the symbol discovered by Regge. Some new formulas are derived from the formalism for cases in which Racah's series for the symbol is summable. (auth)

16958 (UCRL-10336) UNIVERSAL FERMI INTERACTION AND THE MEASUREMENT OF ELECTRIC CHARGE RENORMALIZATION. Malvin A. Ruderman (California. Univ., Berkeley and California. Univ., Berkeley. Lawrence Radiation Lab.). June 28, 1962. Contract W-7405-eng-48. 10p.

A method for comparing the bare electron charge to the measured electron charge by measurement of the ν-e or $\bar{\nu}$-e elastic cross section is discussed. The technique is based on the assumption of a universal Fermi interaction in which the coupling between two electron-neutrino pairs is identical to that between an electron-neutrino and a muon-neutrino pair. Also, an interaction of the form involved requires only the same electromagnetic radiative corrections as the electron-photon vertex in quantum electrodynamics. The nature of the interaction and the corrections are examined, and expressions for the cross sections are presented. (D.C.W.)

16959 A WEIGHTED LEAST-SQUARES PARAMETRIC METHOD OF REDUCING NUCLEAR-REACTOR GAMMA SPECTRAL DATA. J. C. Whiton, R. L. Gamble, and R. M. Thornton (Lockheed Aircraft Corp., Marietta, Ga.). Advan. X-Ray Anal., 5: 306-23(1962).

A mathematical method was developed which reduces nuclear-reactor gamma pulse-height spectral data to the form of differential energy spectra through the use of a high-speed computer machine. In essence, the method consists of a least-squares fit of weighted multichannel analyzer data and the utilization of curve-smoothing parametrization. The least-squares approach tends to reduce the magnitude of data that must be handled, i.e., reduces the order of matrix involved. Weighting is used to obtain fractional deviations for minimization by least squares and thus obtain a satisfactory fit throughout the entire channel range. The parametrization smoothes the reduced data by making use of the fact that reactor gamma spectra can be represented by the product of an exponential and a polynomial. Difficulties that arise when pure matrix inversion is applied were obviated, and the advantage of high-speed data reduction is gained through the use of an IBM 704-7090 computer program. Error analyses were undertaken, and data were reduced for comparative purposes. Results are included in the presentation of the investigation. (auth)

16960 RELATIVISTIC QUANTUM THEORY AS A GROUP PROBLEM. IV. MATHEMATICAL CRITICISM OF SOME CURRENT PHYSICAL TECHNIQUES. Y. Ahmavaara. Ann. Acad. Sci. Fennicae, Ser. A VI, No. 113, 29p.(1962). (In English)

Critical consideration is given to the special assumptions underlying the conventional semi-empirical models of the elementary particles, on the one hand, and the quantum field theories of treating the interactions of particles, on the other. The relation of these restrictive physical techniques to the more general, mathematical basis of relativistic quantum theory is indicated. (auth)

16961 CONCERNING PAIR PRODUCTION ON PROTONS AT HIGH ENERGIES. Werner Ruehl (Universität, Cologne). Ann. Physik (7), 10: 157-200(1962). (In German)

In the production of electron-positron pairs two elementary processes are concerned. In both processes, at energies which are small compared with the rest energy of the protons, the protons enter in only by means of its charge and momentum distribution which they are given by the two Hofstadter form factors. For this energy region a partial cross section was derived. For higher energies in one of the two elementary processes the polarization characteristics of the proton was also considered. Then only those belonging to the other elementary process could be regarded as purely quadratic portions of the partial cross section. All freely available impulses were integrated one after another and the resulting total cross section compared with the cross section in static electric Coulomb fields and in static magnetic dipole fields. (tr-auth)

16962 CERTAIN RECURRENCE RELATIONS FOR APPELL FUNCTIONS USEFUL IN THE CALCULATION OF MATRIX ELEMENTS IN AN ANGULAR MOMENTUM REPRESENTATION. Bengt Nagel, Per Olsson, and Peter Weissglas (Univ. of Stockholm and Royal Inst. of Tech., Stockholm). Arkiv Fysik, 23: 137-43(1963). (In English)

An expansion method and recurrence relations for the expansion terms are given for the radial part of the matrix elements in an angular momentum representation. This method can replace the time-consuming and inefficient method of numerical integration. (C.E.S.)

16963 NOTE ON UNITARY SYMMETRY AND LEPTONIC HYPERON DECAYS. W. Królikowski (Inst. for Nuclear Research, Polish Academy of Sciences, Warsaw and Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 10: 595-9(1962). (In English)

The hypothesis of the unitary symmetry of strong interactions is applied to leptonic hyperon decays. The famous mass formula that agrees remarkably well with experimental masses of baryons and pseudoscalar mesons is given. This formula breaks down the unitary symmetry in a way consistent with this symmetry. (C.E.S.)

16964 ON THE QUANTUM MECHANICAL GENERALIZATION OF BLOCH'S TRANSPORT EQUATION. J. Hajdu (Univ. of Toronto). Can. J. Phys., 41: 533-44(Mar. 1963).

A simple derivation is given of a kinetic equation for a system of free electrons moving in uniform electric and magnetic fields and interacting with fixed scatterers. The kinetic equation describes the asymptotic behavior of the single-electron density operator if it approaches a steady value, or the asymptotic behavior of its average over oscillations if the density operator oscillates in time. This equation, which is effectively the quantum mechanical generalization of Bloch's transport equation, is identical with the one recently derived by Kosevich and Andreev using Bogolyubov's method. More general considerations show that this asymptotic equation is valid and describes the approach to the steady state for weak magnetic fields when the relaxation time is much longer than the atomic time. For strong magnetic fields, the same statement holds if the density operator is averaged over its oscillations, whereas the unaveraged approach toward the steady state is governed by a somewhat different equation. The solutions of these two equations become identical in the most important limiting cases. The results obtained previously by different authors follow from the kinetic equation when further assumptions are introduced. (auth)

16965 EXISTENCE AND SPIN OF THE f^0 RESONANCE. Jean Jacques Veillet, James Hennessy, Harry Bingham, (Universitè, Milan). Compt. Rend., 256: 127-9(Jan. 2, 1963). (In French)

The existence of the particle $f^0 \rightarrow \pi^+\pi^-$ produced in the reactions $\pi^- + p \rightarrow f^0 + n$ at 6.1 Bev/c was proved by a significant peak in the $\pi\pi$ mass spectrum and by the forward-backward symmetry of its decay. The study of the angular distribution of this decay is sharply in favor of a non-zero spin for f^0. Its isotopic spin and its length permit the deduction that f^0 is truly a particle with spin 2 and the identification as the particle predicted in the Chew and Frautschi theory. (tr-auth)

16966 ANALYTICAL PROPERTIES OF THE MESON–NUCLEON VERTEX PORTION AND THE SCATTERING AMPLITUDES OF PSEUDOSCALAR MESONS IN THE PERTURBATION THEORY. M. A. Mestvirishvili and I. T. Todorov (Joint Inst. for Nuclear Research, Dubna, USSR). Dokl. Akad. Nauk SSSR, 148: 562-5(Jan. 21, 1963). (In Russian)

The "majoration" method of Feynman diagrams was studied, taking into account the pseudoscalar nature of π mesons. As a result of this work, primitive physical diagrams were derived for the meson–nucleon vertex portion and the amplitudes of mesons scattered on mesons were determined. The obtained analytical properties of the π-π scattering amplitudes were found sufficient to prove the dispersion relations in case of partial waves, as shown by J. G. Taylor (Nuovo Cimento, 22: 92(1961)). (TTT)

16967 SCATTERING OF CONDUCTION ELECTRONS IN METALS. Ph. Taylor. J. Phys. Radium, 23: 881-3 (Nov. 1962). (In French)

It is suggested that the band structure of a monovalent metal may cause the scattering cross section of impurities to be considerably less than its value for free electrons. It is shown that in the limit of tight binding, the Born approximation is exact. The second Born approximation is calculated for a simple model. (auth)

16968 POSITIVE, NEGATIVE, AND IMAGINARY PROPER MASSES. Ya. (J.) P. Terletskii (Terletsky) (Univ. of Moscow). J. Phys. Radium, 23: 910-20(Nov. 1962). (In French)

The main properties that particles of negative and imaginary proper mass might possess and the properties of systems made of sets of particles of positive, negative, or imaginary proper mass are studied. It is shown that the particles of negative or imaginary mass can be interpreted as real physical entities if the causality principle in physics is considered as a consequence of the second principle of thermodynamics and not as an absolute law (i.e., not statistical) of nature. The general conditions to which the particles of negative or imaginary mass must be set so that they will not violate too greatly the second principle of thermodynamics are analyzed. It is shown that the detection of particles of negative mass demands apparatus of a new type in which the recording part must be in a state of negative temperature. The theoretical possibility of registering the existence of particles of imaginary mass is given. (auth)

16969 CALCULATION OF THE PROPAGATION OF FORBIDDEN COLLISIONS IN π^--PROTON ELASTIC SCATTERING AT ENERGIES BETWEEN 300 Mev AND 9 Bev. Claude Bastard (Institut de Physique Nucléaire, Lyon). J. Phys. Radium, 23: 925-7(Nov. 1962). (In French)

A method given in a previous article is used to calculate the ratio of elastic collisions forbidden in interactions between π and bound protons at energies ranging from 300 Mev to 9 bev. The curves of differential cross sections used are obtained with the help of the optical model and the approximation which was made in neglecting the deformation of the latter with the energy of the π in the motionless nucleon system is justified. (auth)

16970 THE SPATIAL DISTRIBUTION OF ELECTRONS AROUND AN IMPURITY IN THE NEARLY FREE ELECTRON APPROXIMATION. APPLICATION TO THE INDIRECT COUPLING BETWEEN NUCLEAR SPINS BY THE INTERMEDIARY OF CONDUCTION ELECTRONS. G. Gousseland (Faculté des Sciences, Orsay, France). J. Phys. Radium, 23: 928-38(Nov. 1962). (In French)

Assuming a structure of nearly free electrons, an analysis was made of the scattering of the electrons by a localized and small perturbing potential, represented by a "δ" well. It was possible to derive therefrom the spatial electronic distribution as well as the value of the indirect coupling between nuclear spins through conduction electrons. This work only applies to monovalent metals, the Fermi surface of which does not contact the limits of the Brillouin zones. It shows that even in a metal like sodium the corrections to a free electron approximation are important and anisotropic. (auth)

16971 NUCLEON–NUCLEON INTERACTIONS OF ENERGY AROUND 100 Gev. Shigeo Matsumoto (Osaka City Univ.). J. Phys. Soc. Japan, 18: 1-10(Jan. 1963). (In English)

Nine nuclear interactions, observed in a stack of nuclear emulsions, are analyzed in the center-of-mass system. The angular distribution of secondary particles is isotropic for primary energy, E_p, up to several tens of Bev. The distribution shows an appreciable forward-backward collimation for $E_p \simeq 200$ Bev. The average energy of a produced pion is 0.48 Bev. The number of pions at the total energy less than 0.21 Bev is fairly small. The energy spectrum can be

represented by a power law with exponent −2 for the middle region of pion energy. An inspection of experimental results shows that the corresponding exponent for $E_p \gtrsim$ 1400 Bev is −1. The mechanism of multiple production probably changes between 200 and 1400 Bev, and does not differ markedly from several Bev to 200 Bev. (auth)

16972 ELECTRON PENETRATION THROUGH ALUMINIUM. T. Higashimura (Kyoto Univ.). J. Radiation Res. (Japan), 2: 1-19(1961).

The problem of electron penetration is treated analytically in an infinite homogeneous medium employing a segment model on the track of the electron. The intensity of the electron flux was obtained as a function of the energy, the direction of motion, and the spatial variables. The numerical application was done for a 2-Mev perpendicular source in Al. Comparisons were made with Spencer's theory on energy dissipation and it was found that the moment coefficients of the electron flux obtained from both theories are generally consistent with each other. Penetration probability calculated was compared with the experimental results and a fair agreement was found except in a shallow and a very deep layer. Energy distribution of the penetrating electron was also calculated, taking into consideration the straggling of the energy loss, and the experimental plots agreed well with the theoretical distribution curve for moderate and deep penetration. (Abstr. Japan Med., 2: No. 12, Dec. 1962)

16973 NON-COHERENT SCATTERING. I. THE REDISTRIBUTION FUNCTIONS WITH DOPPLER BROADENING. David G. Hummer (University Coll., London). Monthly Notices Roy. Astron. Soc., 125: 21-37(1962).

The redistribution in frequency of radiation scattered from moving atoms is examined in some generality, allowing for the different types of scattering that occur in the atom's rest frame under different circumstances. Some general formulas are obtained and a number of explicit results are given. Finally some attention is devoted to the properties of the redistribution functions and to the methods that may be used for computing them. (auth)

16974 EQUALITY OF VELOCITY OF GAMMA-RAYS OF OPPOSITE CIRCULAR POLARIZATION IN A TRANSVERSE MAGNETIC FIELD. V. Knapp (Univ. of Birmingham, Eng.). Nature, 197: 659-61(Feb. 16, 1963).

Results are reported from an investigation of the influence of the magnetic field on the propagation of light. The Mössbauer effect was used in a study on the equality of velocity of γ rays of opposite circular polarization in a transverse magnetic field. The source, about 80 mc of cobalt-57 diffused into the iron foil and giving the Mössbauer radiation of 14.3 Kev, and the pure natural iron absorber were placed in front of the two opposite melanex windows on the cyclotron vacuum chamber in which a pressure of 10^{-5} mm mercury was maintained through the experiment. The absorber was followed by a PX 130 xenon-filled proportional counter, the output of which was fed into a single-channel pulse height analyzer selecting the 14.3-Kev γ-ray peak. The scaler input was gated with a crystal controlled timing circuit, accurate to better than one part in 10,000. In the course of the experiment, the half-field absorber transmission was compared with the full-field transmission in frequent alternation and the corresponding counting rates, hereafter called HF and FF, recorded. Both HF/FF ratios deviate from unity and there is an increase of absorption at full field. The increase is not due to the effect of the magnetic field on the counter. This effect is due to the fact that, although at half field the absorber material reaches a high degree of magnetization, the complete saturation is not yet attained. Thus, there is an increase in absorption when the polarizing and analyzing field changes from its half field value of 1,250 oersteds to the full field value of 2,500 oersteds, when the material has reached the magnetic saturation. (C.H.)

16975 ON THE THEORY OF WEAK INTERACTIONS. M. A. Markov (Lebedev Inst. of Physics, Moscow). Nucl. Phys., 40: 246-51(Jan. 1963). (In English)

Possibilities are considered for different formulations of the restrictions on four-fermion weak interactions that can lead to the observed forbiddenness. (auth)

16976 WEAK INTERACTIONS IN THE ISOSPACE $\mathfrak{X}(R_3^c)$. Pierre Hillion (Institut Henri Poincaré, Paris). Nucl. Phys., 40: 495-517(Jan. 1963). (In French)

The iso-space $\mathfrak{X}(R_3^c)$, whose elements are the polynomials to each of which one can associate one elementary particle, is the space of the QR_3^c representation of the R_3^* group of the complex orthogonal matrices, holomorphic functions of the ω^{ik} parameters, being the generalization to space-time of the usual Euler angles. It is shown that in $\mathfrak{X}(R_3^c)$ a new group $W-R_3$ is acting, of which the Lie algebra with a representation by the operators $S_j(\omega^{ik}) = J_j(\omega^+) + J_j(\omega^-)$ is invariant under the operator $\mathscr{P}$ corresponding to the usual parity P in the Minkowski universe; $W-R_3$ is a representation of the real orthogonal group R_3. After giving the decomposition of $\mathfrak{X}(R_3^c)$ under $W-R_3$, the form of the elements is studied in each sub-space of this decomposition and that of the lagrangians, scalar under QR_3^c, and invariant under $W-R_3$ and the gauge group G. It is shown that these lagrangians lead to a qualitative description of weak interactions, which seems correctly to represent most experimental results. (auth)

16977 ON UNUSUAL STATISTICS OF ELEMENTARY PARTICLES. P. R. Paula E Silva and Takao Tati (Univ. of São Paulo, Brazil). Nucl. Phys., 40: 518-23(Jan. 1963). (In English)

When a constant vector N_μ is introduced in momentum space (Minkowskian space), a unitary Lorentz-invariant S-matrix can be defined for the non-microcausal (non-local) interactions. The existence of N implies the existence of a special reference system in the Minkowskian space. In this scheme, certain unusual quantizations are possible. As an example, the possibility of the case in which the state vector is symmetric for the interchange of two particles is examined, while nevertheless, the maximum occupation number is one (exclusion principle). This kind of quantum is called b-particle. The b-particle can interact with photons only in very unusual ways, especially in the case of spin $\frac{1}{2}$. The muon is excluded from being a b-particle by its anomalous magnetic moment and the results of pair creation experiments. But experimental data cannot exclude the possibility of π or K being b-particle. (auth)

16978 THE SINGULARITIES OF THE t-MATRIX AFTER A CANONICAL TRANSFORMATION. (ADDENDUM ET CORRIGENDUM). R. Balian (Centre d'Études Nucléaires, Saclay, France) and M. L. Mehta. Nucl. Phys., 40: 524-6(Jan. 1963). (In English)

An error of reasoning is pointed out for a previous paper of the same title. The situation that was overlooked is discussed. (C.E.S.)

16979 PION-PION INTERACTIONS. A. Stanghellini (Università, Bologna and CERN, Geneva). Nuovo Cimento (10), 25: Suppl. No. 2, 108-22(1962). (In Italian)

A general and comprehensive survey is made of the theoretical studies on pion-pion interactions. The importance of pion-pion interactions in the general area of strong interactions is first considered. Then the scattering relations, the peripheral model, and nucleon structure are discussed. (J.S.R.)

16980 ON SMALL-ANGLE SCATTERING AND ABSORPTION OF NEGATIVE PIONS WITH A MOMENTUM OF 5.7 Gev/c IN NUCLEAR EMULSION. B. Jongejans (Universiteit, Amsterdam). Nuovo Cimento (10), 27: 321-41(Jan. 16, 1963). (In English)

Tracks of negative pions of momentum 5.7 Bev/c are followed in nuclear emulsion. In 706 m of pion track 1709 absorption stars are found, yielding a mean free path for star production of (41.4 ± 1.6) cm. In 652 m of particle track, 522 scatterings are also observed, with scattering angles between 0.45 and 8.15°. To find and measure these angles a special recorder is attached to a microscope. Corrections for muons, electrons, and other contaminations of the beam, inelastic scatterings and geometrical losses are taken into account. The optical model is used to interpret the data. The effects of the Coulomb field due to an extended charge distribution are incorporated in the model. For a square-well potential we used three variable parameters, $R_0(R = R_0A^{\frac{1}{3}})$, W and $V_0(V = V_0 - iW)$. The best fit for the experiment with an estimated error is R_0 = (1.20 ± 0.05) fermi, W = (41 ± 7) Mev, V_0 = (13 ± 10) Mev. A tapered-well potential as found with electron-scattering data was also used in the analysis. The best parameter values are then: W = (44 ± 8) Mev, V_0 = (30 ± 10) Mev. (auth)

16981 K^- INTERACTIONS IN DEUTERIUM: π^-pY FINAL STATES. O. Dahl (Univ. of California, Berkeley), D. Miller, J. J. Murray, and N. Horwitz. Nuovo Cimento (10), 27: 342-56(Jan. 16, 1963). (In English)

The PANG and KICK computer programs were used to re-analyze a sample of 396 K^-d interactions that lead to $\Lambda\pi^-p$ and $\Sigma^0\pi^-p$ final states. Tests made to check the validity of the KICK fits show that the calculated uncertainties in fitted parameters are too small by (20 to 40)% and that systematic errors are less than or on the order of the calculated uncertainties. For K^- interactions at rest the $\Lambda\pi^-p/\Sigma^0\pi^-p$ ratio is 10 ± 2. Thirty-eight $\Lambda\pi^-p$ and 15 $\Sigma^0\pi^-p$ events arising from in-flight interactions yield the following cross-sections: 61 ± 26, 49 ± 15, 35 ± 10, 22 ± 10 for Λ production and 11 ± 11, 11 ± 7, 15 ± 7, 6.5 ± 5 for Σ^0 production for K^- momentum intervals (60 to 110), (110 to 160), (160 to 210), and (210 to 260) Mev/c respectively. Final state interactions are important in each category of events. If f is the fraction of events whose proton momentum distribution fit the spectator model then f equals 0.12 and 0.50 for $\Lambda\pi^-p$ and $\Sigma^0\pi^-p$ respectively when the K^- interacts at rest and 0.65 and 0.55 when the K^- interacts in flight. In the $\Lambda\pi^-p$ final states there was evidence for the two step process $K^- + d \rightarrow \pi^- + \Sigma$ + nucleon followed by $\pi^- + \Sigma$ + nucleon $\rightarrow \pi^- + \Lambda^0 + p$. The decay angular distribution of the Λ's produced in this two-step process yields a value of $\alpha\overline{p} = 0.05 \pm 0.16$. A measurement of the Λ lifetime yields the value $\tau = (2.40 \pm 0.17) \times 10^{-10}$ s. (auth)

16982 ANGULAR CORRELATIONS IN Λ β-DECAY. L. Egardt (University Coll., London). Nuovo Cimento (10), 27: 357-67(Jan. 16, 1963). (In English)

A current-current type of interaction is assumed with the conventional lepton current coupled to a general hyperon current involving 6 unknown form factors. The expression obtained for the electron-proton angular correlations is to a large extent dominated by phase space and, for reasonable assumptions about the form factors, the angular distribution of electrons with respect to the proton momentum is always peaked in the backward direction. This also holds true for a scalar, pseudoscalar or a tensor interaction. Finally, some comments are made on the effect of an intermediate particle. (auth)

16983 ON THE Λ_{e3} DECAY. L. Egardt (University Coll., London). Nuovo Cimento (10), 27: 368-75(Jan. 16, 1963). (In English)

Expressions for the proton spectrum are obtained under the assumption of a current-current interaction and for a scalar and tensor interaction. If the induced form factors are neglected and the V – A form factors are assumed to be constant the spectrum yields useful information about the relative strength of the vector and axial vector current. (auth)

16984 ONE-PARTICLE EXCHANGE IN ANTIPROTON COLLISIONS IN FLIGHT. D. Bessis, C. Itzykson, and M. Jacob (Centre d'Études Nucléaires, Saclay, France). Nuovo Cimento (10), 27: 376-83(Jan. 16, 1963). (In English)

The very strong forward peaking recently observed in $\bar{p}p \rightarrow \bar{\Lambda}\Lambda$ collisions at 3 Bev/c suggests that the reaction could proceed mainly through the exchange of a strangeness 1 isospin $\frac{1}{2}$ meson. This hypothesis was tested by means of an angular correlation measurement between the directions of the pions emitted in the hyperon and antihyperon decays. (auth)

16985 THE ANGULAR DISTRIBUTION OF THE PHOTOPRODUCTION OF POSITIVE PIONS FROM HYDROGEN BY 187 Mev γ-RAYS. G. M. Lewis, D. W. G. S. Leith, D. L. Thomas, R. Little, and E. M. Lawson (Univ. of Glasgow). Nuovo Cimento (10), 27: 384-93 (Jan. 16, 1963). (In English)

The differential cross section for π^+ photoproduction from hydrogen by γ rays of laboratory energy 187 Mev was measured at four angles. Two identical counter systems, designed to detect low energy pions unambiguously in intense electron and γ ray backgrounds, were used in conjunction with a cylindrical liquid hydrogen target, of very low boil-off rate. The cross sections at laboratory angles of 39.2, 66.7, 111.6, and 134° are 7.49 ± 0.47, 8.10 ± 0.57, 8.36 ± 0.61, and 9.54 ± 0.61 × 10^{-30} cm^2/sr, respectively, where the assigned errors refer only to the relative values. The absolute cross sections are in substantial agreement with the dispersion theory and confirm the front to back asymmetry. (auth)

16986 POSITRON-ELECTRON ANNIHILATION IN FLIGHT AT 600 Mev. E. Malamud and R. Weill (Université, Lausanne, Switzerland). Nuovo Cimento (10), 27: 418-24(Jan. 16, 1963). (In English)

About 30 km of 600 Mev positron tracks were followed in a propane bubble chamber operating in a magnetic field. 575 positron-electron annihilation events were observed giving, after corrections, a cross-section of 1.563 mb ± 4.5%. The experimental corrections are small and are described in detail. The result is compared with the calculation of lowest-order quantum electrodynamics. The ratio $\sigma_{exp}/\sigma_{th.\ lowest\ order}$ = 1.085 ± 0.047. This ratio together with those obtained from other experiments are compared to theoretical predictions of deviations from the lowest-order calculation due to radiative corrections and due to possible failures in quantum electrodynamics. (auth)

16987 SEARCH FOR THE PHOTOPRODUCTION OF THE η^0-MESON. K. Berkelman, A. Franklin, D. McLeod, S. Richert, and A. Silverman (Cornell Univ., Ithaca, N. Y.). Nuovo Cimento (10), 27: 497-503(Jan. 16, 1963). (In English)

An attempt was made to detect the photoproduction of the η^0 by observation of recoil protons at fixed momentum and angle from the reaction $\gamma + p \rightarrow p + \eta^0$. The yield as a function of bremsstrahlung peak energy should exhibit an abrupt increase as the incident peak energy becomes sufficient to produce the η^0 in coincidence with the observed recoil proton. Measurements were made every 25 Mev with 1% accuracy from below the single-pion threshold to about 1100 Mev at a 35° proton angle and at three proton momenta (420, 550, and 638 Mev/c). No steps in the excitation function were seen; in particular, a statistical analysis sets upper limits of about 0.5 μb/sr at each of the three proton momenta for the photoproduction of a mass 550 Mev particle. The overall shapes of the curves (apart from the single-pion production) are consistent with the phase space for double-pion production. (auth)

16988 IRREDUCIBLE INTERNAL VARIABLES OF ELEMENTARY PARTICLES AND WEAK INTERACTION SYMMETRY. T. Takabayasi (Univ. of Nagoya, Japan). Nuovo Cimento (10), 27: 504-12(Jan. 16, 1963). (In English)

The set of irreducible internal variables for elementary particles is given, which reproduces leptons and strongly interacting particles in quadruplet and octet schemes, respectively. From this standpoint a universal model of weak interactions is proposed which incorporates $\Delta S = -\Delta Q$ processes, based on a particular discrete symmetry. (auth)

16989 CHIRALITY AND THE STRUCTURE OF THE PION-NUCLEON INTERACTION. Y. Oishi. Nuovo Cimento (10), 27: 513-24(Jan. 16, 1963). (In English)

The concept of chirality invariance is extensively applied to the direct four-fermion interaction of the nucleon-antinucleon system. It is shown that if the chirality concept is extended to the isotopic spinor, P-invariance is derived in a natural way, and if this concept is further extended (according to Watanabe-Tanikawa) to the tensor quantities appearing in the interaction Lagrangian, (parity conserving) V + A or V − A is suggested as the type of basic interaction. Based on the Fermi-Yang model, effective pion-nucleon couplings are derived by the use of the chain approximation, and it is found that the V + A and V − A correspond to the pseudoscalar and pseudovector pion-nucleon couplings respectively. Some remarks concerning the results are made, in view of the symmetry of strong interactions. (auth)

16990 ADDITIONAL SOLUTIONS TO THE DIRAC EQUATION WITH YUKAWA POTENTIAL. P. Burt and W. K. R. Watson (California Inst. of Tech., Pasadena). Nuovo Cimento (10), 27: 525-9(Jan. 16, 1963). (In English)

The Dirac equation is shown to have extra solutions when the dimensionless coupling constant γ^2 exceeds $^3/_4$. The physical ambiguities of these solutions are clarified by the incorporation of Regge's treatment of angular momentum. (auth)

16991 REMARK ON THE MASS OF THE MUONIC NEUTRINO. S. Śniegocki (Inst. of Physics, Polish Academy of Sciences, Warsaw). Nuovo Cimento (10), 27: 536-7(Jan. 16, 1963). (In English)

The isotropic electron spectrum from μ^+ meson decay is given for an electronic neutrino mass not identically zero, extending the usefulness of the electron spectrum method for determining the mass of the muonic neutrino. The result is valid for the universal Fermi interaction of four component fermions μ, e, ν, and λ. (C.E.S.)

16992 A REMARK ABOUT REGGE POLES FOR HARD-CORE POTENTIAL SCATTERING. G. Berendt (Freie Universität, Berlin). Nuovo Cimento (10), 27: 550-2(Jan. 16, 1963). (In English)

The question of whether the analytic properties of the scattering amplitude in the complex angular momentum plane are affected by a hard-core potential is discussed. The scattering problem of quantum mechanics with such a potential is then exactly the same as a well known one in classical acoustics, namely the diffraction of an incident plane wave by a soft sphere. (C.E.S.)

16993 DISCUSSION OF A $3^-/2$ OCTET. Y. Dothan, H. Harari, and S. Nussinow (Israel Atomic Energy Commission Labs., Rehovoth). Nuovo Cimento (10), 27: 553-4 (Jan. 16, 1963). (In English)

An attempt is made to fit N_1^*, Y_1^*, Y_0^{**}, and Ξ^* into a $3^-/2$ octet taking into account the masses and decay modes of the resonances. (C.E.S.)

16994 ON THE QUANTUM NUMBERS OF THE η-PARTICLE. R. Querzoli and V. Silvestrini (CNEN, Rome). Nuovo Cimento (10), 27: 555-8(Jan. 16, 1963). (In English)

The experimental basis on which the 0−+ (spin 0, parity −1, G-parity +1) quantum number assignment was given to the η meson was discussed. (C.E.S.)

16995 A POSSIBLE DETERMINATION OF THE SPIN AND RELATIVE PARITY OF THE HYPERON ISOBARS. C. Itzykson and M. Jacob (Centre d'Études Nucléaires, Saclay, France). Phys. Letters, 3: 153-5(Jan. 1, 1963). (In English)

A method is proposed for determining the spins and parities of the hyperon resonances. The method is based on the analysis of angular and polarization correlations, in the forward direction, for the interactions $N + \bar{N} \rightarrow \bar{Y} + Y^*$. N represents a nucleon, Y a hyperon, and Y* a hyperon resonance. (T.F.H.)

16996 A MODEL FOR THE VIOLATION OF THE $|\Delta I| = {}^1/_2$ RULE IN $K_{\pi 3}$ DECAYS AND ITS EXPERIMENTAL IMPLICATIONS. C. Bouchiat, J. Nuyts, and J. Prentki (CERN, Geneva). Phys. Letters, 3: 156-7(Jan. 1, 1963). (In English)

A model is described in which the observed deviation from the $|\Delta I| = {}^1/_2$ rule in $K_{\pi 3}$ decay is explained without assuming that the weak-interaction Hamiltonian for nonleptonic decay of strange particles contains a term having isospin $^3/_2$. The major assumption of the model is that the deviation from the $|\Delta I| = {}^1/_2$ rule is produced by an enhancement of the electromagnetic corrections to the amplitude of K_1^0 decay, which enhancement is a result of the presence of the η^0 meson with a mass close to that of the K meson. (T.F.H.)

16997 INFRARED SINGULARITIES IN ELECTRON-PHONON [PROTON] SCATTERING. L. D. Soloviev (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 3: 172-3(Jan. 1, 1963). (In English)

The form of the singularity of the electron-proton scattering amplitude near zero momentum transfer is found, using the renormalization group. This singularity is a pole, multiplied by a relativistic Coulomb-like phase factor. A relativistic generalization of a Regge trajectory for a H atom is also obtained. Only the electromagnetic e-p interaction is considered. (T.F.H.)

16998 STATISTICAL MECHANICS OF BOSONS AND FERMIONS WITH NEGATIVE ENERGIES. V. Vyšín (Palacky Univ., Olomouc, Czechoslovakia). Phys. Letters, 3: 174-5(Jan. 1, 1963). (In English)

The positive and negative energy levels of boson and fermion systems are analyzed. The relation between the positive- and negative-energy fermions is discussed, and it is noted that no such simple interpretation can be found relating the positive- and negative-energy bosons. (T.F.H.)

16999 COULOMB INTERFERENCE IN HIGH-ENERGY p-p SCATTERING. R. J. N. Phillips (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Letters, 3: 184-5(Jan. 1, 1963). (In English)

It is conjectured that Coulomb interference can be appreciable in small-angle p-p scattering, up to quite high energies. It is noted that this interference can be used to test the Regge pole hypothesis and other theories, in particular as they apply to: the real part of the nuclear spin-independent amplitude; the sign of this real part; and spin-dependent terms. (T.F.H.)

17000 ON A GENERALISATION OF THE GELL-MANN ROSENFELD TRIANGLE FOR Σ-DECAYS. R. F. O'Connell and L. O'Raifeartaigh (Inst. for Advanced Studies, Dublin). Phys. Letters, 3: 197-8(Jan. 1, 1963). (In English)

It is assumed that the interaction hamiltonian of non-leptonic processes (e.g., Σ decay) can have terms arising from both $|\Delta t| = \frac{1}{2}$ and $|\Delta t| = \frac{3}{2}$ contributions, where t is the total isospin. The predictions arising from this assumption are compared with experimental Σ^+ and Σ^- decay data. The effect of a $|\Delta t| = \frac{5}{2}$ admixture is also discussed. (T.F.H.)

17001 DO STRANGE PARTICLES OBEY PARASTATISTICS? H. Feshbach (CERN, Geneva). Phys. Letters, 3: 317-19(Feb. 15, 1963). (In English)

The possibility that strange particles obey parastatistics and that the strangeness selection rules and the phenomena of associated production in strong interactions are a consequence of the conservation of statistics was explored and found to be possible. Some additional simple postulates to parastatistics were required. (C.E.S.)

17002 AN EXTENSION OF ADAIR'S ANALYSIS: A METHOD FOR DETERMINING SPINS AND PARITIES OF EXCITED BARYONS. S. Barshay (Brandeis Univ., Waltham, Mass.). Phys. Letters, 3: 320-2(Feb. 15, 1963). (In English)

A method was outlined for determining the spin and parity of any excited baryon that decays strongly into a spin zero meson and a spin one-half baryon. This method was applicable to photon-nucleon reactions in which there was produced a single spin zero meson and any one of the family of excited baryon states which subsequently decays strongly. (C.E.S.)

17003 REGGE POLE HYPOTHESIS AND POLARISATIONS IN πp AND Kp SCATTERING. H. Ueberall (Univ. of Michigan, Ann Arbor). Phys. Letters, 3: 323-5(Feb. 15, 1963). (In English)

Expressions for the polarizations in π-p, K-p, and $\bar{K}$-p scattering are presented together with differential and total cross sections. (C.E.S.)

17004 A NOVEL EFFICIENT METHOD FOR MEASURING THE POLARISATION OF POSITRONS. L. Dick, L. Feuvrais, L. Madanski, and V. L. Telegdi (CERN, Geneva). Phys. Letters, 3: 326-9(Feb. 15, 1963). (In English)

A novel method for measuring the polarization of positrons was described. The method requires a comparatively small number of positrons to establish the sign and possibly the magnitude of the polarization. For this reason it may be of interest for helicity measurements in the positron decay of elementary particles, where the available source strengths are usually rather weak. (C.E.S.)

17005 OPTICAL MODEL WITH TENSORIAL POTENTIALS FOR THE ELASTIC SCATTERING OF INTERMEDIATE ENERGY DEUTERONS. J. Raynal (Centre d'Études Nucléaires, Saclay, France). Phys. Letters, 3: 331-3(Feb. 15, 1963). (In English)

An optical model is used to analyze the elastic scattering of deuterons, taking into account tensorial terms for spin 1 particles. Polarizations are obtained by a refined calculation of the cross sections. The results are analyzed in terms of previous experimental data for actual scattering. (C.E.S.)

17006 SOME LOW ENERGY PROTON-ANTIPROTON CROSS SECTIONS. J. G. Loken and M. Derrick (Oxford Univ.). Phys. Letters, 3: 334-5(Feb. 15, 1963). (In English)

Measurements of the cross sections for charge-exchange scattering, $\bar{p} + p \rightarrow \bar{n} + n$, and for $\bar{p} + p \rightarrow$ mesons are given for antiprotons from the CERN synchrotron stopping in the Saclay 81-cm hydrogen bubble chamber. The low energy data for these cross sections were extended down to 20 Mev for the charge-exchange scattering and 32 Mev for annihilation into mesons. (C.E.S.)

17007 STUDY OF 224 τ'^+ DECAYS. G. Giacomelli (Università, Bologna and Instituto Nazionale di Fisica Nucleare, Bologna), D. Monti, G. Quareni, A. Quareni-Vignudelli, W. Puschel, and J. Tietge. Phys. Letters, 3: 346-8(Feb. 15, 1963). (In English)

The analysis of a sample of 224 τ' decays at rest that were found in two Ilford K5 emulsion stacks exposed to the 700 Mev/c K^+ beam at the Berkely Bevatron was presented. The study of the τ and τ' decay modes of the K meson allows in principle the study of low energy pion-pion interaction and a test of the $\Delta I = \frac{1}{2}$ selection rule. (C.E.S.)

17008 PHOTON SCATTERING IN THE LOW FREQUENCY HIGH INTENSITY LIMIT. Z. Fried (Naval Ordnance Lab., Silver Springs, Md.). Phys. Letters, 3: 349-51(Feb. 15, 1963). (In English)

It is shown that the photon-electron scattering amplitude exhibits nonlinear effects. The nature of these effects are discussed. The scattering amplitude and the differential scattering cross section depend in a non-trivial fashion on the intensity of photons incident on the target in the scattering process. (C.E.S.)

17009 PROTON-DEUTERON INTERACTIONS AT 77 Mev. M. Davidson, H. W. K. Hopkins, L. Lyons, and D. F. Shaw (Nuclear Physics Lab., Oxford). Phys. Letters, 3: 358(Feb. 15, 1963). (In English)

The Oxford 12-cm deuterium bubble chamber was used with the Harwell cyclotron to examine the interaction of 77-Mev protons with deuterons. An analysis based on 2000 events was presented. A total cross section of 146 ± 7 mb and a total elastic cross section of 55 ± 3 mb were obtained, with a cutoff applied at angles less than 10° to remove the forward scattering Coulomb peak. (C.E.S.)

17010 DEUTERON-DEUTERON SCATTERING AT 20–70 Mev. L. Lyons, J. E. A. Lys, and H. W. K. Hopkins (Nuclear Physics Lab., Oxford). Phys. Letters, 3: 359-60 (Feb. 15, 1963). (In English)

The Oxford 12-cm deuterium bubble chamber was used

to study interactions in the d-d system in the energy range 20–70 Mev. A preliminary analysis of 1000 interactions was presented that listed the possible reactions, their cross sections, and branching ratios. (C.E.S.)

17011 EQUIVALENCE OF THE BRYSK APPROXIMATION AND THE DETERMINANTAL METHOD. David S. Falk (Univ. of Maryland, College Park). Phys. Rev., 129: 2340-1(Mar. 1, 1963).

Brysk's approximation for scattering from a spherically symmetric potential, obtained by iterating on the asymptotic expression for the scattered wave in an asymptotically valid equation for the exact wave function, is demonstrated to be equivalent to the lowest order approximation in the determinational method based on the Fredholm solution for an integral equation. (D.C.W.)

17012 EXPERIMENTAL LIMITS FOR THE ELECTRON-PROTON CHARGE DIFFERENCE AND FOR THE CHARGE OF THE NEUTRON. Jens C. Zorn, George E. Chamberlain, and Vernon W. Hughes (Yale Univ., New Haven). Phys. Rev., 129: 2566-76(Mar. 15, 1963).

Upper limits for the electric charges on the atoms of cesium and potassium and the molecules of hydrogen and deuterium are measured by a molecular beam deflection method. The results are: $q(Cs) = (1.3 \pm 5.6) \times 10^{-17}\ q_e$, $q(K) = (-3.8 \pm 11.8) \times 10^{-17}\ q_e$, $|q(H_2)| < 2 \times 10^{-15}\ q_e$, and $|q(D_2)| < 2.8 \times 10^{-15}\ q_e$ (q_e is the absolute value of the electron charge). The results are consistent with the view that atoms and molecules are electrically neutral. The results on H_2 and D_2 provide direct upper limits of $1 \times 10^{-15}\ q_e$ for the electron-proton charge difference and $2.4 \times 10^{-15}\ q_e$ for neutron charge. The cesium result can be interpreted as showing that the magnitude of the electron charge differs from that of the proton by less than 5 parts in 10^{19} and that the neutron charge is less than $5 \times 10^{-19}\ q_e$. The relevance of charge equality to cosmological theory, and to the theory of elementary particles, is discussed. (auth)

17013 UPPER LIMIT OF THE ELECTRIC DIPOLE MOMENT OF THE ELECTRON. J. Goldemberg and Y. Torizuka (Stanford Univ., Calif.). Phys. Rev., 129: 2580-1(Mar. 15, 1963).

A new upper limit on the electric dipole moment of the electron is established by measurements of the scattering of electrons by He^4 at 180° where the charge scattering is zero. The experiment was performed at a momentum transfer of $q = 0.44 \times 10^{13}\ cm^{-1}$ and indicate that the electric dipole moment of the electron is $\lesssim 10^{-15}$ e cm, where e is the charge of the electron. (auth)

17014 ANALYSIS OF THE HYPERTRITON IN TERMS OF HARD-CORE POTENTIALS. B. W. Downs (Univ. of Colorado, Boulder), D. R. Smith, and T. N. Truong. Phys. Rev., 129: 2730-8(Mar. 15, 1963).

The variation method is used to set upper bounds on the strength of the average Λ-nucleon potential in the hypertriton ($_\Lambda H^3$) required to reproduce the observed binding energy of that system for assumed hard-core radii of 0.2, 0.4, and 0.6 F. Only two-body Λ-nucleon potentials are considered. Although the well-depth parameter of the required potential increases as the assumed hard-core radius is increased, it seems unlikely that even the largest of the hard-core radii considered would imply a bound state for the hyperdeuteron ($_\Lambda H^2$). The possibility that the scattering length and the effective range of the required potential may be insensitive to the value of the hard-core radius is discussed. (auth)

17015 ELASTIC K^+-PROTON SCATTERING AT 970, 1170, AND 1970 Mev/c. V. Cook, D. Keefe, L. T. Kerth, P. G. Murphy, W. A. Wenzel, and T. F. Zipf (Univ. of California, Berkeley). Phys. Rev., 129: 2743-54(Mar. 15, 1963). (UCRL-10183)

A liquid-hydrogen target surrounded by spark chambers was used to study K^+-proton elastic scattering at 970, 1170, and 1970 Mev/c incident K^+ momentum. In contrast with results at lower energies, the angular distributions were not isotropic; the anisotropy increases with energy, while the elastic cross section decreases. A number of phase-shift solutions using (a) $S_{\frac{1}{2}}$, $P_{\frac{1}{2}}$, and $P_{\frac{3}{2}}$ complex phase shifts; (b) real $S_{\frac{1}{2}}$, $P_{\frac{1}{2}}$, and $P_{\frac{3}{2}}$, and complex $D_{\frac{3}{2}}$ phase shifts; and (c) complex $S_{\frac{1}{2}}$ and $D_{\frac{3}{2}}$, and real $P_{\frac{1}{2}}$ and $P_{\frac{3}{2}}$ phase shifts have been found for the 970- and 1170-Mev/c data. The 1970-Mev/c distribution has been fitted by an optical model. The data presented here have been included with other information on K-nucleon scattering in a test of forward-scattering dispersion relations. The data are still insufficient to provide a definitive test; however, an acceptable fit was found for Γ (effective pole residue) = −0.1 ± 0.3. (auth)

17016 BARYON MASS SPLITTING AND WEAK AND STRONG COUPLINGS. Kalyana Mahanthappa and William Ramsay (Univ. of California, Los Angeles). Phys. Rev., 129: 2755-8(Mar. 15, 1963).

The mass difference between various baryons is attributed to the presence of bosons weakly coupled to a primary baryon. As an example, the case of ΣΛ is treated assuming the Σ − Λ parity to be even. An eigen-value condition derived by Albright, Blankenbecler, and Goldberger, using the N/D method, is rederived simply. This derivation not only clarifies the assumptions, but makes the algebraic handling of the problem very simple. (auth)

17017 SCATTERING OF 8-Gev μ MESONS ON ELECTRONS. G. Backenstoss, B. D. Hyams, G. Knop, P. C. Marin, and U. Stierlin (CERN, Geneva). Phys. Rev., 129: 2759-65(Mar. 15, 1963).

The scattering of polarized 8-Bev μ^- mesons on electrons in magnetized iron was measured. The spin dependence of the cross section gives the helicity for μ^- mesons from π^- decay. The cross section for producing knock-on electrons up to 3.4 Bev is compared with the value calculated in first order, corrected for the emission of hard photons. Measurement and calculation of the cross section agree within the experimental error, which is ±7%. (auth)

17018 ELECTROMAGNETIC INTERACTIONS OF NEUTRINOS. Leonard Rosenberg (Univ. of Pennsylvania, Philadelphia). Phys. Rev., 129: 2786-8(Mar. 15, 1963).

The cross sections for the process (a) ν + nucleus → ν + γ (virtual Coulomb) + nucleus → $\nu + \gamma$ + nucleus and the related process (b) γ + nucleus → $\gamma + \gamma$ (virtual Coulomb) + nucleus → $\nu + \bar{\nu}$ + nucleus are calculated to lowest order in the weak and electromagnetic interactions, assuming the existence of a direct electron-neutrino weak interaction. While the relevant Feynman amplitude is given by a formally divergent expression, a finite amplitude is obtained by imposing the condition of gauge invariance. The contribution of process (b) to the neutrino luminosity of stars is worked out and found to be somewhat smaller than that of the processes: $e^- + e^+ \rightarrow \nu + \bar{\nu}$, $\gamma + e^\pm \rightarrow e^\pm + \nu + \bar{\nu}$. The present calculation is motivated by recent suggestions that stellar evolution may be significantly affected by energy lost by the star due to the emission of neutrinos. A very crude estimate is given for the contribution of the process (c) $\gamma + \gamma \rightarrow \nu + \bar{\nu} + \gamma$ to the neutrino luminosity. It is pointed out that a calculation of process (b) which exists in the literature is non-gauge-invariant. (auth)

17019 ANGULAR DISTRIBUTION OF MUONS IN π-μ DECAY AT REST. H. Hulubei, J. S. Auslaender, E. M. Friedlaender, and Ş. Ţiţeica (Inst. of Atomic Physics, Bucharest). Phys. Rev., 129: 2789-2801(Mar. 15, 1963).

Evidence for a significant departure from isotropy of the muon angular distribution from π-μ decay at rest is presented, based on measurements of projected angles in two emulsion stacks, exposed to the Dubna and CERN synchrocyclotrons. Extensive control experiments concerning observational bias, distortion, and inhomogeneous detection efficiencies prove that the observed lack of isotropy cannot be reduced to such spurious effects. (auth)

17020 DETERMINATION OF THE DEUTERON FORM FACTOR FROM COHERENT π^0 PHOTOPRODUCTION. J. I. Friedman and H. W. Kendall (Stanford Univ., Calif.). Phys. Rev., 129: 2802-7(Mar. 15, 1963).

Coherent photoproduction of π^0 mesons from deuterium was used to measure the deuteron form factor. Measurements of the production cross section were carried out for photon energies from 470 to 514 Mev by detecting momentum-analyzed recoil deuterons. These measurements were analyzed in terms of the impulse approximation calculation of Hadjioannou. The deuteron form factor has been determined in the range of momentum transfers from 1.74 to 2.74 F^{-1}. The results are consistent with the predictions of a repulsive core potential; however, there is some ambiguity in the interpretation due to the uncertainty in the magnitude of the multiple scattering corrections to the impulse approximation. Measurements of the cross section were also made as a function of photon energy for two constant momentum transfers, 1.76 and 1.96 F^{-1}. The range of energies covered was 300 to 500 Mev. The results indicate that there is a large reduction of the cross section with respect to the impulse approximation prediction near the (3,3) resonance. This is in qualitative agreement with calculated corrections arising from multiple scattering of the meson in the deuteron. The measurements show that this deviation decreases as the photon energy increases in the region above resonance. (auth)

17021 SINGULARITIES IN THE ANGULAR MOMENTUM PLANE. I. R. Garland and J. W. Moffat (RIAS, Baltimore). Phys. Rev., 129: 2812-15(Mar. 15, 1963).

Evidence for the existence of cuts in the angular momentum plane is discussed and the recent experimental data from CERN on p-p scattering are interpreted in terms of a simple model with a Pomeranchuk pole $\alpha_p(t)$ [$\alpha_p(0) = 1$] and a cut extending as far as $\mathrm{Re}\alpha(t) = 1$ for all t. A fit is obtained to the p-p data in the region between 3–30 Bev/c and there is a pronounced flattening of the curves for $d\sigma/dt$ above 20 Bev/c, but the total cross section still approaches a constant value and the model yields a shrinkage of the diffraction peak, though more slowly than in the single-pole model without a cut. The presence of a cut also provides a natural explanation of the effects previously attributed to a second Pomeranchuk trajectory. Due to the competition of the cut and the pole near $t = 0$ the value of the trajectory $\alpha_p(t)$ cannot be accurately determined for small $|t|$ with the present experimental data, and it is possible that $d\alpha_p(0)/dt$ is, in fact, much smaller than that obtained from only a pole model and may even be zero. The calculations suggest that more accurate data with $t \sim -0.8$ are most likely to decide whether Regge poles are the only singularities determining high-energy scattering. (auth)

17022 PARTICLES WITH ZERO MASS AND PARTICLES WITH "SMALL" MASS. F. Coester (Argonne National Lab., Ill.). Phys. Rev., 129: 2816-17(Mar. 15, 1963). (TID-17784; UAC-6970)

The irreducible representations of the inhomogeneous Lorentz group which describe, respectively, particles with and without mass are qualitatively different. Nevertheless, the zero-mass representations can be obtained from the representation with mass by letting the mass go to zero. Particles of sufficiently small mass or sufficiently high energy behave like particles of zero mass. (auth)

17023 ASYMPTOTIC BEHAVIOR OF THE S MATRIX FOR HIGH ANGULAR MOMENTUM. A. M. Jaffe (Princeton Univ., N. J.) and Y. S. Kim. Phys. Rev., 129: 2818-23 (Mar. 15, 1963).

The behavior of the partial-wave transition matrix is discussed for large values of the angular momentum. For physical values of the angular momentum, it is shown that the N-channel T matrix vanishes in the high angular momentum limit. The validity of the optical model is discussed. In the Gelfand-Levitan formalism, it is shown that the two Jost functions coincide as the angular momentum goes to infinity along the real axis. For the Yukawa-type potentials, it is shown that the transition matrix reduces to its Born term as the real part of the complex angular momentum variable goes to infinity. (auth)

17024 POLARIZATION IN NEUTRON-PROTON SCATTERING AT 23.1 Mev. R. B. Perkins and J. E. Simmons (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 130: 272-5(Apr. 1, 1963). (LADC-5512)

A measurement of n-p polarization was made at 23.1 Mev neutron energy of higher precision and of greater angular range than data previously available. The T(d,n) He^4 reaction was used as a source of monoenergetic, highly polarized neutrons, and a solenoid was used to precess the incident spin polarization for the asymmetry measurements. The values of polarization for laboratory scattering angles of 25, 35, 45, 55, 65 and 75 deg were measured to be $+0.0492 \pm 0.0140$, $+0.0529 \pm 0.0100$, $+0.0522 \pm 0.0071$, $+0.0310 \pm 0.0071$, $+0.0247 \pm 0.0090$, and -0.0036 ± 0.0090, respectively. The Basel sign convention is used. Comparison is made with several theoretical predictions and differences between theory and experiment are found to be small. (auth)

17025 LOW-ENERGY Σ^-p AND Σ^-d INTERACTIONS AND THE PION-HYPERON COUPLING CONSTANTS. J. J. de Swart and C. K. Iddings (Univ. of Chicago). Phys. Rev., 130: 319-26(Apr. 1, 1963). (EFINS-62-46)

By means of a static hyperon-nucleon potential, the fraction, $\Sigma^0/(\Sigma^0 + \Lambda)$ is calculated, for the low-energy reactions: $\Sigma^- + p \rightarrow n \rightarrow \Sigma^0$ or Λ and $\Sigma^- + d \rightarrow 2n + \Sigma^0$ or Λ. The parameters in this potential are the pion-hyperon coupling constants, $f_{\Lambda\Sigma}$ and $f_{\Sigma\Sigma}$, and the cores in the $^3S_1$ and $^1S_0$ states. These parameters are restricted to values that will reproduce the ΛN scattering lengths. Both even and odd Σ parity are considered. Agreement is not found for global symmetry, but small $f_{\Sigma\Sigma}$ ($\lesssim 0.1$), in particular unitary symmetry, agrees very well with experiment. Solutions can also be found for the case of odd Σ parity. (auth)

17026 SEARCH FOR $\mu \rightarrow e + e + e$. S. Frankel (Univ. of Pennsylvania, Philadelphia), W. Frati, J. Halpern, L. Holloway, W. Wales, F. W. Betz, and O. Chamberlain). Phys. Rev., 130: 351-4(Apr. 1, 1963).

A search was made for the neutrinoless decay mode $\mu \rightarrow e + e + e$. Positive pions from the Berkeley 184-in. synchrocyclotron were stopped in a lithium target. The detection of three decay particles not in coincidence with an incoming pion served to trigger two thin-plate spark chambers viewing the decays. The energy of the decay particles was measured with a combination of NaI counters and range telescopes. The spark chamber pictures were

first scanned for events with three tracks meeting at a common point in the target. A requirement that no angle between any of the three tracks could be greater than 160° eliminated essentially all of the main source of background, namely, knock-on collisions of electrons passing through the target. Further requirements for the three tracks to be coplanar and for each particle to have at least 16 Mev eliminated all but one ambiguous event. For this event insufficient energy information was available. If we assume that one event to be $\mu \rightarrow e + e + e$, and with a calculated detection efficiency of 0.0083, an upper limit for the branching ratio for this mode can be set at 1.5×10^{-7} with a 90% confidence level. (auth)

17027 3 π DECAY MODES OF $K^{\pm}$ AND η. Claude Kacser (Columbia Univ., New York). Phys. Rev., 130: 355-6(Apr. 1, 1963).

Present experimental results on τ, τ′, and $\eta \rightarrow 3\pi$ decay are shown to imply either that these decays all pass through an intermediate virtual one-pion state; or that there exists an S-wave 2π resonance of low mass, such as the recently reported φ, that, however, has yet to be confirmed. It is not possible simply to invoke a pure I = 1 final state in each of the three decays, since other evidence shows that, in the absence of such a resonance, the $K^{\pm} \rightarrow 3\pi$ effective weak Lagrangian density contains both nonderivative and derivative coupling. The ηx spectrum, while presently unreliable, shows evidence against such a resonance, but further experiments are needed. Here x is the usual Dalitz variable, related to the $\pi^{+}\pi^{-}$ energy difference. (auth)

17028 EXPERIMENTAL STUDY OF DOUBLE-CHARGED PION PRODUCTION IN (π^{-},p) COLLISIONS AT 900 Mev. Derek C. Colley and Joseph T. Ratau (Columbia Univ., New York). Phys. Rev., 130: 357-61 (Apr. 1, 1963).

Eight hundred and forty events of the kind $\pi^{-} + p \rightarrow \pi^{-} + p + \pi^{-} + \pi^{+}$ produced in the 20-in. BNL hydrogen bubble chamber by 900-Mev pions were unambiguously identified using spatial reconstruction and kinematic fitting programs as well as ionization density estimates. The π^{+},π^{-} and π^{-},π^{-} combined mass distributions can be fitted by smooth curves, with no deviation beyond statistical fluctuations; no indication was found of any prominent pion-pion resonance in this interaction, which covers a mass range up to 610 Mev. The π^{+},p combined mass distribution differs markedly from the four-body phase-space curve, but can be well fitted by weighing the π^{+},p total cross section curve at each point according to the amount of phase space available for production of an isobar of corresponding mass. Assuming that the interaction proceeds exclusively via formation of the (π^{+},p) isobar, one can get a good fit to the π^{-},π^{-} mass spectrum. This isobar model is also consistent with all of the observed angle and momentum distributions for both pions and protons. The momentum distributions show no indication of any pion-pion-proton resonance in the range up to 1550 Mev, or of any three-pion resonance in the range up to 750 Mev. The cross section for the events studied was measured and found to be (0.33 ± 0.04) mb. (auth)

17029 IMPROVED MINIMUM PRINCIPLE FOR SINGLE-CHANNEL SCATTERING. Yukap Hahn, Thomas F. O'Malley, and Larry Spruch (New York Univ., New York). Phys. Rev., 130: 381-94(Apr. 1, 1963).

The minimum principle for single-channel scattering obtained previously required the introduction of channel radii for an incident relative kinetic energy E greater than zero. The channel radii, which greatly complicate the numerical calculations, no longer appear in recent formal theories of reactions and they need not appear in the minimum principle formulation. By projecting out all of the open-channel components from the full wave function, it is possible to eliminate the continuum states of the total Hamiltonian H originally present below E. The closed-channel Hamiltonian $\mathcal{H}$ has only a discrete spectrum below the inelastic threshold. By appropriately subtracting the contributions from the discrete portion of the spectrum, $\mathcal{H}$ can be used to obtain a minimum principle for $k \cot\eta$, where η is the phase shift. This minimum principle provides a rigorous criterion for determining the parameters in a trial function and for choosing among the numerical results obtained with different trial functions. The method requires that one solve exactly the static approximation equation, which plays a particular role in uncoupling the closed-channel equations from the open-channel equation. Finally, contact is made with the results previously obtained at zero energy and a generalized Levinson's theorem is briefly considered. (auth)

17030 COLLISION LIFETIMES IN MANY-BODY PROCESSES. Felix T. Smith (Stanford Research Inst., Menlo Park, Calif.). Phys. Rev., 130: 394-401(Apr. 1, 1963).

Collision lifetimes and the lifetime matrix are expressly formulated so as to include three-body and many-body collision and breakup processes. The many-body states are expressed in the generalized angular momentum representation, in which the principal radial coordinate is proportional to the square root of the trace of the inertia tensor for the N-body configuration. The physical significance of the (energy-dependent) three-body collision lifetime $Q^{(3)}(E)$ is clarified by considering the special case where the three-body breakup occurs by way of a metastable two-body intermediate. If the metastable occurs with an internal energy E_m and a decay time τ_m, and the process creating it has a collision lifetime $Q^{(2)}(E - E_m)$, the connection with $Q^{(3)}$ is: $Q^{(3)}(E) = Q^{(2)}(E - E_m) + \tau_m E_m/E$. This result holds both classically and quantally. (auth)

17031 ZERO-TEMPERATURE PROPERTIES OF THE MANY-FERMION SYSTEM. G. Horwitz (Cornell Univ., Ithaca, N. Y.), R. Brout, and F. Englert. Phys. Rev., 130: 409-19(Apr. 1, 1963).

It is shown that the class of correlation graphs that arise in the calculation of thermodynamic properties in the canonical ensemble can be summed to give renormalized single-particle populations. In the limit of zero temperature the perturbation expansion of the energy then reduces to the adiabatic expansion of Goldstone about the correct model state. Arguments for the consistency of the expansion are developed for the case of the nonspherical Fermi surface. (auth)

17032 REGGE TRAJECTORIES AND ELEMENTARY POLES. Reinhard Oehme (Univ. of Chicago). Phys. Rev., 130: 424-8(Apr. 1, 1963). (EFINS-62-64)

Elementary poles are introduced as poles of physical partial wave amplitudes $F_l(s)$ that are not present in the analytic interpolating function $F(s,\lambda)$. It is shown that $F_l(s) = F(s,l)$ for $l > 1$, and that all particles with a spin larger than one must be members of Regge trajectories; only bosons are considered explicitly. Additional restrictions are discussed that would make it possible to eliminate elementary poles also for spin one and zero. The possibility that the physical s-wave amplitude $F_0(s)$ is not determined by the interpolation function $F_+(s,0)$ could be used to avoid the ghost associated with the vacuum trajectory. The problem of branch-point trajectories is discussed briefly. (auth)

17033 EXTENSION OF THE REGGE REPRESENTATION. N. N. Khuri (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev., 130: 429-35(Apr. 1, 1963).

The Regge formula is modified in such a way as to exhibit the "full" contribution of each Regge pole to the scattering amplitude. In this modified form both the contribution from each pole and the new background term have the correct cuts in the z plane. In the case where the partial wave amplitude is meromorphic in the whole l plane it is shown that, under certain assumptions, the scattering amplitude can be represented by a series sum of contributions from the Regge poles. Each contribution has the correct cut in the z plane, and the series converges for all z in the cut plane. An approximation of the scattering amplitude at low energies in terms of a few contributions from leading poles is discussed. Finally, it is shown that this modified Regge formula leads to a relatively simple bootstrap procedure for constructing the scattering amplitude from unitarity and analyticity. (auth)

17034 CROSSING SYMMETRY IN S-MATRIX THEORY. A. O. Barut (Univ. of Colorado, Boulder). Phys. Rev., 130: 436-9(Apr. 1, 1963).

A general method is given to calculate the crossing relations for arbitrary processes that is based on the transformation properties of the amplitudes and analytic continuation only. The helicity amplitudes as well as the so called R and M amplitudes are considered and some simple examples are worked out. (auth)

17035 CONSTRUCTION OF INVARIANT SCATTERING AMPLITUDES FOR ARBITRARY SPINS AND ANALYTIC CONTINUATION IN TOTAL ANGULAR MOMENTUM. Asim O. Barut, Ivan Muzinich, and David N. Williams (Univ. of California, Berkeley). Phys. Rev., 130: 442-57 (Apr. 1, 1963). (UCRL-10463)

From group-theoretical considerations, invariant scattering amplitudes for two-body reactions of particles with arbitrary spins and nonzero masses are constructed in various forms, including helicity amplitudes and amplitudes free of kinematical singularities. They are linear combinations of spin basis functions with scalar coefficients. In the process of construction the Pauli spin matrices are generalized for arbitrary spin. On the basis of a Mandelstam representation for the scalar coefficients, the unique analytic continuation of the amplitudes in total angular momentum is obtained. Possible kinematical singularities of the scalar amplitudes at the boundary of the physical region are discussed. (auth)

17036 POSSIBILITY FOR COPIOUS PRODUCTION OF THE INTERMEDIATE VECTOR BOSONS. Gyo Takeda (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 167-70(Mar. 1, 1963). (UCRL-10599)

The possibility that some of the intermediate vector bosons of the weak interaction might be produced, several orders of magnitude more strongly than previously estimated, is studied. Intermediate vector bosons interact with the strangeness-non-changing baryon current, the strangeness-changing baryon current, and the lepton current. Circumstance that could give rise to copious production of the intermediate bosons are presented. (C.E.S.)

17037 PION RESONANCES, REGGE POLES, AND THE CHEW-FRAUTSCHI SATURATION PRINCIPLE. Louis A. P. Balázs (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 10: 170-2(Mar. 1, 1963).

It was shown by means of a crude model that the positions of the resonances in low energy π-π scattering were unaffected by inelastic effects whereas their widths were considerably narrowed. A simple self-consistent calculation for the high-energy total cross section was carried out by making some simplifying assumptions for the Regge trajectory and imposing a saturation condition. (C.E.S.)

17038 NUCLEON AS A REGGE POLE AND THE $J = \frac{1}{2}$, $T = \frac{1}{2}$ πN PHASE SHIFTS. N. N. Khuri and B. M. Udgaonkar (Inst. for Advanced Study, Princeton, N. J.). Phys. Rev. Letters, 10: 172-6(Mar. 1, 1963).

An effective-range-type formula was proposed for the $J = \frac{1}{2}$, $T = \frac{1}{2}$ πN phase shift, based on the idea that the nucleon was a Regge pole. It was shown that this formula gave an accurate description of this phase shift up to ~225 Mev. (C.E.S.)

17039 SPIN OF THE Y_1^*. L. Bertanza (Brookhaven National Lab., Upton, N. Y.), V. Brisson, P. L. Connolly, et al. Phys. Rev. Letters, 10: 176-9(Mar. 1, 1963). (BNL-6634)

Evidence was presented on the Y_1^* ($\Lambda\pi$ system) spin. The observed decay correlations indicated a spin $\geq \frac{3}{2}$. The Y_1^*'s were produced by the interaction of 2.24-Bev/c K^- mesons, in the reaction $K^- + p \rightarrow \Lambda^0 + \pi^+ + \pi^-$. (C.E.S.)

17040 SPIN AND PARITY OF THE 1385-Mev Y_1^* RESONANCE. Janice B. Shafer, Joseph J. Murray, and Darrell O. Huwe (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 179-83(Mar. 1, 1963). (UCRL-10623)

Study of the reaction $K^- + p \rightarrow Y^{*\pm} + \pi^\pm \rightarrow \Lambda + \pi^+ + \pi^-$ at a momentum of 1.22 Bev/c showed conclusively that the spin of the 1385 Mev Y_1^* is $\geq \frac{3}{2}$. It also indicated that the Y_1^* state is $P_{\frac{3}{2}}$ (even Y^*-Λ parity) rather than $D_{\frac{3}{2}}$ (odd parity). These conclusions resulted from the angular distribution of the Λ and the angular dependence of the Λ polarization. The events were obtained through the use of the 72-in. hydrogen bubble chamber placed in a beam of high-energy K^- mesons extracted from the Bevatron. (C.E.S.)

17041 1660-Mev Y_1^* HYPERON. Luis W. Alvarez, Margaret H. Alston, Massimiliano Ferro-Luzzi, et al. (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 184-8(Mar. 1, 1963). (UCRL-10569)

The three and four body final states produced in the $K^- + p$ interactions at $p_K = 1.51$ Bev/c ($E_{C.M.} = 2025$ Mev) were studied to obtain information on the existence and properties of the 1685 Mev Y_1^*. The effective-mass distributions for these events established the existence of an $I = 1$ resonant state, Y_1^*, with mean energy $M^* \approx (1660 \pm 10)$ Mev and full width at half-maximum $\Gamma \approx (40 \pm 10)$ Mev. The possible relevance of $Y_1^*(1660$ Mev) to the recently proposed SU(3) symmetry scheme was discussed. (C.E.S.)

17042 K^--p INTERACTIONS NEAR 760 Mev/c. Pierre L. Bastien and J. Peter Berge (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 188-92(Mar. 1, 1963). (UCRL-10570)

The results of a study of the $K^- + p$ system at incident K^- laboratory momenta of 620, 760, and 850 Mev/c were presented. Only the most important features of the interactions were obtained at each of these momenta. At 620 Mev/c the system is dominated by strong $S_{\frac{3}{2}}$ absorption. At 760 Mev/c effects of $Y_1^*(1660$ Mev) were observed. At 850 Mev/c large $\frac{3}{2}$ or $\frac{5}{2}$ amplitudes set in. (C.E.S.)

17043 EIGHTFOLD-WAY ASSIGNMENTS FOR $Y_1^*(1660)$ AND OTHER BARYONS. Sheldon L. Glashow and Arthur H. Rosenfeld (Univ. of California, Berkeley). Phys. Rev. Letters, 10: 192-6(Mar. 1, 1963). (UCRL-10579)

It was shown that the partial widths for the various two-body decay modes of the γ octet and of the δ decuplet were compatible with unitary symmetry of strong interactions.

The experimental partial widths for decay into meson plus baryon were summarized. Two of these were used as input variables determining the eightfold-way D and F decay-coupling-constants for the γ octet; the remaining five partial widths were calculated after adjustment of a radius of interaction. The calculation was repeated for the δ decuplet. Agreement with experiment was found. (C.E.S.)

17044 QUANTIZATION OF ELEMENTARY PARTICLE MASSES. Ernest E. H. Shin (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 10: 196-8(Mar. 1, 1963).

The quantization of elementary particles was attributed to the dynamics described by the internal space-time variables and their corresponding 4-momenta. A mass operator was defined, which met all of the requirements of the principle of reciprocity and relativistic covariance. The center-of-mass kinematics were given in the Klein-Gordon form. The mass eigenvalue equation was solved, and led to a quantized mass formula. The development of the theory revealed some basic properties of a bilocal field associated with elementary particles. (C.E.S.)

17045 VECTOR MESONS AND THE POMERANCHUK TRAJECTORY. Peter G. O. Freund and Reinhard Oehme (Univ. of Chicago). Phys. Rev. Letters, 10: 199-201 (Mar. 1, 1963).

Within the framework of dispersion theory, it was shown that an elementary pole describing a vector particle necessarily induces a Regge trajectory with $\alpha(0) = 1$ and positive signature, provided the pole appears in the crossed channel of an elastic scattering amplitude. The possibility that the Regge pole with $\alpha(0) = 1$ has a superimposed branch or that it is a double pole is not excluded. If a vector meson is described by a Regge pole, the argument for the existence of an induced Pomeranchuk trajectory does not apply. (C.E.S.)

17046 SIMPLICITY OF REGGE ASYMPTOTIC AMPLITUDES. William G. Wagner (California Inst. of Tech., Pasadena). Phys. Rev. Letters, 10: 202-3(Mar. 1, 1963).

It was shown that nucleon-nucleon scattering analyses that were complicated by the use of standard spinor formalism could be simplified by the use of the Regge asymptotic amplitudes. With the approach presented, all asymptotic formulas could be given for total cross sections, two-body differential cross sections, and polarization phenomena in meson-meson, meson-baryon, and baryon-baryon scattering. (C.E.S.)

17047 ON THE TWO-NUCLEON SPIN-ORBITAL INTERACTIONS. Yu. G. Pavlenko. Vestn. Mosk. Univ., Ser. III, No. 5, 30-4(Sept.-Oct. 1962). (In Russian)

An analysis was made of a pole-type diagram for nucleon interactions in a symmetric pseudoscalar field. Expansion of v/c to a v^2/c^2 order contributed to the LS potential. (tr-auth)

17048 ON THE DECAY $\pi \rightarrow e + \nu + \gamma$. V. F. Mueller (Universität, Heidelberg). Z. Physik, 172: 224-30(1963). (In German)

The radiative decay of the charged π-meson $\pi^+ \rightarrow e + \nu + \gamma$ was calculated using dispersion relation techniques. It is assumed that the weak interaction producing the decay has a V-A structure. The decay through the vector variant was reinvestigated and found to be different from the result of Vaks and Ioffe. The theoretical prediction is in agreement with a preliminary experiment recently performed at CERN. (auth)

17049 CALCULATED RATES FOR THE REACTION $\mu^- + He^3 \rightarrow H^3 + \nu$. Hans Georg Wahsweiler (Universität, Freiburg i. B.). Z. Physik, 173: 375-85(1963). (In English)

The effective Hamiltonian of Morita and Fujii was used to calculate the muon capture rate Λ_μ in He^3. The calculation was done including and omitting the "weak magnetic interaction" and for positive and negative sign of pseudoscalar coupling. The results are related to the known value of $\underline{ft}$ for the beta decay of the triton. The rms radius of the charge distribution in He^3 was taken to be 1.55 fm rsp. 1.85 fm. (The first value follows from the results of the variational calculation of Kikuta, Morita, and Yamada, the last value is based on a variational calculation for a potential with a long tailed attractive part.) The capture rates differ by 10% for the two rms radii. The result for v_{rms} = 1.55 fm deviates slightly from the corresponding result of Werntz. (auth)

17050 DATA ON THREE-PION INTERACTION. Ya. Ya. Shalamov and A. F. Grashin (Inst. of Theoretical and Experimental Physics, USSR). Zh. Eksperim. i Teor. Fiz., 44: 65-7(Jan. 1963). (In Russian)

The $\pi^- + n \rightarrow \pi^- + \pi^- + \pi^0 + p$ reaction for an initial π^--meson momentum of 2.8 Bev/c is studied with aid of a 17-liter bubble chamber filled with a freon mixture. Indications are obtained that three-pion resonances for an isospin I = 2 may exist for masses $M_\pi \approx 0.45$, 0.63, 0.87, and 1.05 Bev. (auth)

17051 ANGULAR DEPENDENCE OF THE POLARIZATION CORRELATION C_{nn} AND RECONSTRUCTION OF THE AMPLITUDE MODULI FOR pp SCATTERING AT 640 Mev. ESTIMATION OF THE SINGLET PHASE SHIFTS. [PART] II. B. M. Golovin, V. P. Dzhelepov, R. Ya. Zulkarneev, and Wa-Chuang Ts'ui (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 142-7(Jan. 1963). (In Russian)

Experiments on triple scattering of protons are described, and the results of measurement of the spin correlation coefficients C_{nn} for 640-Mev protons elastically scattered by protons are presented for a number of angles in the cms which differ from 90°. On basis of the experimental data obtained in the present work and available in the literature, the moduli of the pp-scattering amplitudes are qualitatively determined in a broad angular range $50° < \theta < 130°$ and their relative contributions are given. The values of the singlet and triplet cross sections for some angles are also determined. The phase shifts for a pp-system at the indicated energy in singlet states are estimated. (auth)

17052 RESONANCE PHENOMENA IN THE MOTION OF A PARTICLE IN A PLANE ELECTROMAGNETIC WAVE. A. A. Kolomenskii and A. N. Lebedev. Zh. Eksperim. i Teor. Fiz., 44: 261-9(Jan. 1963). (In Russian)

The motion of a particle in the field of a plane electromagnetic wave in the presence of an external magnetic field is considered. It is shown that under certain conditions resonance effects occur which involve a growth of the particle energy. Increase of the energy does not violate the resonance condition. (auth)

17053 CONCERNING THE DETERMINATION OF THE ELECTRON FORM FACTOR. A. A. Bogush and I. S. Satsunkevich (Inst. of Physics, Academy of Sciences, Belorussian SSR). Zh. Eksperim. i Teor. Fiz., 44: 303-5 (Jan. 1963). (In Russian)

The differential cross sections for scattering of high-energy electrons with a distributed charge and magnetic moment are computed by taking into account the initial and final longitudinal polarizations. A simple scheme is indicated for determining the electron form factors in this case and also when only the initial (final) polarizations are fixed. (auth)

17054 APPLICATION OF CONFORMAL MAPPING FOR EXTRAPOLATION INTO THE NONPHYSICAL REGION OF DEPENDENCES OBSERVED IN THE SCATTERING OF HIGH-ENERGY PARTICLES. Yu. M. Kazarinov, F. Legar, and I. N. Silin (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 311-15 (Jan. 1963). (In Russian)

Conformal mapping is employed for solving the problem of determination of the coupling constant and spectral functions of the nucleon-nucleon scattering amplitude. (auth)

17055 ON DETERMINATION OF THE K*-MESON SPIN. S. M. Bilenkii and R. M. Ryndin (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 326-8(Jan. 1963). (In Russian)

A possible method of determining the K*-meson spin is discussed which is based on a study of $(K,\bar{K}^*)$ or $(\bar{K},K^*)$ pair production due to collision of oppositely moving electron-positron beams. (auth)

17056 DECAY OF ULTRAHIGH-ENERGY PARTICLES IN CONDENSED MATTER. M. I. Ryazanov (Moscow Inst. of Physical Engineering). Zh. Eksperim. i Teor. Fiz., 44: 355-60(Jan. 1963). (In Russian)

Decay of a fast particle involving a small transfer of momentum from atoms of the matter as a result of Coulomb scattering is considered. It is shown that interference of Coulomb scattering of the initial particle and the decay products leads to an appreciable decrease of the decay probability at ultrahigh energies. (auth)

17057 NECESSARY EXPERIMENT IN PROTON-PROTON SCATTERING. N. P. Klepikov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 376-81(Jan. 1963). (In Russian)

It is shown that the determination of n parameters of the proton-proton scattering matrix may be reduced with account of unitarity to n + 1 measurements in sufficiently accurate experiments on single, double, and triple scattering of protons. (auth)

17058 ON THE CALCULATION OF ENERGY MATRIX FOR THE SYSTEM OF IDENTICAL PARTICLES WITH ORDERED SPIN. I. G. Kaplan (Karpov Inst. of Physics and Chemistry, USSR). Zh. Eksperim. i Teor. Fiz., 44: 382-3(Jan. 1963). (In Russian)

Transformation permutation group matrices used in calculation of two-shell element configurations were developed and tabulated for possible symmetry groups with 3 to 6 total particle numbers. The table also includes the permutation matrix group in the expressions describing operator matrix elements for two-particle interactions $\underline{G}$ in the system found in the field with an arbitrary symmetry and non-conservation of motion moment. (R.V.J.)

17059 REMARKS ON THE LOW-ENERGY π-π SCATTERING. N. B. Pivovarova (Inst. of Mathematical Computer Center, Siberian Section of the Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 383-5(Jan. 1963). (In Russian)

Solutions for low-energy π-meson scattering were previously found using A_0- and A_1-wave resonances (with I = S = 0 and I = S = 1 respectively). The p-wave resonance is specified by a large A_0 wave. Without the A_0 wave resonance the p-wave solution does not satisfy the threshold condition $[A_1(\nu)/\nu = 0] \neq 0$. The upper boundary for p-resonance width is at 50 Mev and is related to the A_0 wave saturation. The Chew and Mandelstam equations for s and p waves in $\pi\pi$-scattering were resolved previously. In order to obtain the p-wave resonance, the left non-physical pole is either ignored ($\Lambda \approx 10^5$) or replaced by remote pole $\nu = -10^3$. Resonance solutions were found only in the p wave specified by the "bootstrap" mechanism. It was shown that the resonance is determined by the contributions of the left pole remote singularities. (R.V.J.)

17060 LECTURES ON THE MANY-BODY PROBLEM. E. R. Caianiello, ed. New York, Academic Press, 1962. 352p. $10.50.

Eighteen lectures given at the Second International Spring School of Physics held at the University of Naples are presented. Most of the lectures deal with the theory of Fermi gases, but some material concerning Bose and electron gases and nuclear matter is included. Recent developments in investigations of ground state properties, equilibrium properties at positive temperatures, and transport properties are discussed. Separate abstracts were prepared for each lecture. (A.G.W.)

17061 GROUND STATE THEORY OF IMPERFECT FERMI GASES. L. Van Hove (Inst. of Theoretical Physics, Utrecht). p.5-21 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The perturbation approach to the ground state theory of a dilute Fermi gas having forces is presented. Various aspects of the difficulties inherent to it are indicated. An argument to the effect that the perturbation treatment may not be valid for attractive forces (Cooper, Phys. Rev., 104: 1189(1956)) is reviewed and then extended and modified to apply to repulsive forces. Finally, it is shown on a model calculation (dealing with density fluctuations of an ideal Fermi gas in the ground state) that the convergence properties of the linked cluster expansion may be governed by conditions entirely foreign to the true physical nature of the problem. A similar mathematical difficulty is likely to affect the linked cluster expansion for the imperfect Fermi gas. (A.G.W.)

17062 CANONICAL TRANSFORMATION FOR THE FERMI GAS. G. Fano (Instituto Nazionale di Fisica Nucleare, Bologna). p.23-9 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

A possible approach to Fermi gas theory is discussed, the aim of which is to retain the good features of the Bogoliubov canonical transformation method and the Goldstone expansion of connected graphs. Part of the results are already well known. Good agreement with experiment (in the case of superconductivity) indicates that the theory has some domain of validity. (A.G.W.)

17063 GENERAL PERTURBATION FORMALISM FOR THE MANY-BODY PROBLEM AT NONZERO TEMPERATURES. C. Bloch (Centre d'Etudes Nucléaires, Saclay, France). p.31-56 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

A method for calculating the grand partition function is described. An expansion in powers of the activity is established, its similarity to the corresponding expansion of classical statistical mechanics is discussed, and a partial summation of additional turns in the diagrams is performed. The same result is then obtained in a different way by computing the trace with the help of an appropriate generalization of Wick's theorem. Some consequences of the trace invariance of the expansion are derived, and a time-independent formulation is obtained. (A.G.W.)

17064 ON THE THEORY OF ELECTRON TRANSPORT. E. Verboven (Rijksuniversiteit, Utrecht). p.57-72 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

Some general simplifications of the Kubo formula are given and the conventional expression for the electrical conductivity tensor is derived from the formula in the special case of elastic scattering by randomly distributed impurities. The higher order terms are calculated, and an exact formula for the conductivity tensor to second order is obtained. The importance of the higher order terms is discussed. (A.G.W.)

17065 COMPARISON OF SOME DIFFERENT LINKED-CLUSTER EXPANSIONS. A. Reiner (Weizmann Inst. of Science, Rehovoth, Israel). p.73-9 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The relation between different approaches to linked-cluster expansions of the partition function of a gas is established. It is argued that the multiple scattering formalism is best suited for a calculation of the fundamental cluster coefficients. A method of calculating the underlying generalized scattering operator is indicated, and the results of an application to a nonideal gas with a hard-core interaction are mentioned. (A.G.W.)

17066 FUNCTIONAL INTEGRALS IN STATISTICAL MECHANICS. J. S. Bell (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.81-9 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

It is shown how functional integration and related techniques can be taken over from field theory into quantum statistical mechanics. The object is to obtain, for quantities of interest, closed formal expressions involving only c-numbers rather than the q-numbers of the basic formulation. The mathematics is strictly experimental, and no questions of rigor or convergence are considered in this tentative outline. (A.G.W.)

17067 FORMAL THEORY OF THE OPTICAL MODEL. J. S. Bell (Atomic Energy Research Establishment, Harwell, Berks, Eng.). p.91-100 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The elastic scattering of a nucleon by a nucleus presents a many-body problem. But much empirical data are well represented by a simple one-body model in which the target nucleus is replaced by a complex potential well. It is hoped, therefore, that the solution of the many-body problem could be seen to fall naturally into two stages, first the identification of an equivalent one-body potential, and then the solution of the one-body scattering problem with this potential. The extent to which this hope has been fulfilled so far at the purely formal level is discussed. (A.G.W.)

17068 MOMENT OF INERTIA OF LARGE SUPERFLUID SYSTEMS OF FERMIONS. R. E. Prange (Inst. for Theoretical Physics, Copenhagen). p.101-14 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The calculation of the moment of inertia of very large systems, called nuclei, is considered. No actual nuclei are as large as the ones considered, but the dimensions of the nuclei must be large in comparison with a certain correlation length characteristic of the superfluid properties, and this length is estimated to be about 10 times the size of the largest nuclei observed in nature. Attempts to calculate the moment of inertia for real nuclei are reviewed. By calculations based on the cranking model, a formula for the large system is produced, which predicts the correct mass and has a reasonable limit. (A.G.W.)

17069 LECTURES ON THE GREEN'S FUNCTION METHOD. R. E. Prange (Inst. for Theoretical Physics, Copenhagen). p.115-32 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The Cooper pair problem is discussed. The effect on the two-particle Green's function of the various corrections to the original ladder-graph approximation and the effect of the hole-hole scattering corrections to the Brueckner theory or the Bethe-Goldstone wave function are considered. (A.G.W.)

17070 LEVEL DENSITY FOR NUCLEONS IN A p-SHELL. R. Balian (Centre d'Études Nucléaires, Saclay, France). p.133-8 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

Statistical methods are used in discussing the problem of level density for a simple model of interacting particles. An exact solution and an approximate method are considered. The approximate method used consists of two steps: (1) the grand partition function $Z(\alpha,\beta)$ is calculated by a perturbation method; (2) the level density is deduced from it by the Darwin-Fowler method. (A.G.W.)

17071 GENERAL PERTURBATION FORMALISM FOR THE MANY-BODY PROBLEM AT NONZERO TEMPERATURE. [PART] II. R. Balian (Centre d'Études Nucléaires, Saclay, France). p.139-62 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

Two problems are discussed: (1) the zero-temperature limiting case for fermions, and (2) the expression of physical quantities in terms of the true occupation number, $n(k) = 1/Z \text{ Tr} \exp[-\beta H + \alpha N] a_k^+ a_k$. The same methods of summation of diagrams are used in both cases with different starting points. (A.G.W.)

17072 GENERAL PERTURBATION FORMALISM FOR THE MANY-BODY PROBLEM AT NONZERO TEMPERATURE. C. De Dominicis (Centre d'Études Nucléaires, Saclay, France). p.163-89 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The consequences of the D-theorem on the structure of the grand partition function and other thermodynamic quantities are derived. The properties of the Green's function in this respect are examined. Three formulations for the Gibbs potential $A = -(1/\beta) \log Z$ are considered. The one examined in most detail leads to a representation in terms of the occupation number that presents some analogies with some recent work of Lee and Yang (Phys. Rev., 117: 22(1960)). (A.G.W.)

17073 APPROACH TO EQUILIBRIUM IN WEAKLY INTERACTING SYSTEMS. D. L. Falkoff (Brandeis Univ., Waltham, Mass.). p.191-8 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The problem of describing the approach to equilibrium of a system of weakly interacting particles by means of a distribution function satisfying the following requirements is considered: (1) it should give as complete a description of nonequilibrium configurations as conventional statistical mechanics does for weakly interacting systems in thermal equilibrium; (2) it should be specified for all time; (3) in the limit of $t \to \infty$, it should approach the thermal equilibrium distribution. It is shown that distributions satisfying the above three requirements can be obtained as solutions of suitable master equations. These give the change in time of the joint distribution in occupation numbers of individual particle states in terms of the transition probabilities between states due to interactions. (A.G.W.)

17074 ON THE CONVERGENCE AND ANALYTIC PROPERTIES OF THE LINKED CLUSTER EXPANSION. A. Katz (Weizmann Inst. of Science, Rehovoth, Israel). p.199-214 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

Some general considerations related to the behavior and convergence properties of the Goldstone expansion are presented. Some of the considerations are then demonstrated in a simple soluble model. (A.G.W.)

17075 DIELECTRIC FORMULATION OF MANY-BODY PROBLEMS. A. J. Glick (Weizmann Inst. of Science, Rehovoth, Israel). p.215-38 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

A many-body system extending over a large region of space and having an interparticle interaction that depends only on the distance between particles is considered. The properties of the generalized dielectric constant ϵ and the relation between ϵ and other properties of the system are discussed. Then the present analysis is related to a perturbation treatment using Feynman diagrams, from which it is shown that the generalized dielectric constant has a definite microscopic significance and is closely related to the quantum mechanical polarization propagator. This approach is extensively applied to the electron gas, and some of the results are summarized. (A.G.W.)

17076 ASPECTS OF THE THEORY OF SUPERCONDUCTIVITY. G. Rickayzen (Univ. of Liverpool). p.239-63 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The most important and most difficult part of the theory of superconductivity lies in isolating that part of the interactions in a metal which gives rise to the superconducting state. The electron-phonon interaction is first considered, since it is primarily responsible for the transition. Part of the Coulomb interaction is then taken into account, and a criterion for the appearance of superconductivity among the metals is derived. An explanation for the Meissner-Ochsenfeld effect (the fact that the lines of force do not penetrate the bulk of material when a superconductor is placed in a magnetic field of low intensity) is discussed. (A.G.W.)

17077 NONPERTURBATION LINKED-CLUSTER EXPANSION OF THE FERMI GAS WAVE FUNCTION. H. Kuemmel (Max-Planck-Institut für Chemie, Mainz). p.265-77 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

The correlation structure of a Fermi gas with given density is discussed. Without use of perturbation theory, the linked-cluster theorem is formulated and proved. The convergence of the linked cluster series is assumed, and the individual clusters are not defined by series expansions. (A.G.W.)

17078 THEORY OF NORMAL FERMION SYSTEMS. A. Klein (Univ. of Pennsylvania, Philadelphia). p.279-334 of "Lectures on the Many-Body Problem." New York, Academic Press, 1962.

A systematic account of normal Fermion systems at or near the absolute zero of temperature is developed. By a normal Fermion system is meant one whose properties can be studied by means of a power series development in the potential assumed to act between the particles. The complete power series for the ground state energy is derived. It is then shown that the theory at finite temperatures can be formulated in close analogy to what was done at zero temperature. (A.G.W.)

17079 STRANGE PARTICLES AND STRONG INTERACTIONS. R. H. Dalitz. Tata Institute of Fundamental Research Studies in Physics. Oxford, Oxford University Press, 1962. 194p.

Reactions involving strongly interacting particles and their resonant states were discussed. The properties of these particles and the basic principles established for the reactions were reviewed. A formal reaction theory was developed that maintained unitarity for reaction amplitudes. This formalism was applied to the analysis of some particular reaction processes. (C.E.S.)

17080 IONIZING RADIATIONS. TECHNICAL CALCULATIONS. TABLES OF NUMERICAL VALUES FOR THE USE OF ENGINEERS, RADIOLOGISTS, AND OFFICIALS. Lucien Brunelet. Paris, Gauthier-Villars, 1960. 74p. (In English; also, French, Italian, and Spanish)

A compilation of the numerical evaluations used in the calculation of the intensity of radiation and its absorption is presented. (J.S.R.)

17081 A LEAKY WAVE APPROACH TO ČERENKOV AND SMITH-PURCELL RADIATION. István Palócz. Thesis, Brooklyn, Polytechnic Inst., 1962. 150p.

The effect of the interaction between a linearized modulated electron beam of finite thickness and the electromagnetic field is investigated for Cherenkov and Smith-Purcell radiation under self-consistent conditions. The eigenwavenumbers of the space-charge waves are calculated for a sheet beam in free space and for a similar beam passing between two plane-parallel plates. This calculation leads to a denumerably infinite set of eigenpropagation wavenumbers for both the fast and slow waves. These wavenumbers are real for both cases. The beam in free space calculation can be made the starting point of a linear perturbation procedure for the Cherenkov effect. The perturbation consists of the introduction of two semi-infinite dielectric regions; through the gap of these the sheet beam of finite thickness passes. The eigenwavenumbers must be complex for this case, if Cherenkov radiation is present. It is shown that the fast and slow waves behave differently and that only the fast space-charge waves contribute to radiation. The fast space-charge waves are leaky waves; thus this radiation is a leaky-wave phenomenon. The slow waves do not leak, but are attenuated transversely. A similar calculation has been carried out for the case of a small-signal modulated sheet beam passing between two plane-parallel, zero-thickness, perfectly conducting transmission gratings, i.e., an example of the Smith-Purcell effect. In contrast to the previous case, space harmonics arise due to the periodicity of the grating. Only these space harmonics may radiate if the gratings are located in vacuum. For this case the far-field behavior of the gratings must first be evaluated by solving the integral equation for one grating in free space under multimode conditions. Then, knowing the eigenwavenumbers for the beam between two conducting plates, the boundary perturbations (the replacement of the plates by gratings) can be taken into account by a linear perturbation calculation. The propagation wavenumbers are also complex for the perturbed case, and only the fast waves contribute to radiation. The possibility of backward waves is also shown. The analytical results, which are presented in graphical form, take into account the finite thickness and the space-charge characteristics of the beam. (Dissertation Abst., Vol 23, No. 7)

17082 PHOTOPRODUCTION OF NEUTRAL MESONS FROM HYDROGEN NEAR THRESHOLD. Fatin Yusuf

Bulos. Thesis, Stanford, Calif., Stanford Univ., 1962. 105p.

The angular distributions of neutral pions produced from H by the bremsstrahlung beam of the Stanford linear accelerator were studied at three γ energies 185, 170, and 160 Mev. A "thin" H gas target ($\simeq$35 psi pressure) was used. The recoil protons from the process $\gamma + p \rightarrow \pi^0 + p$ were momentum analyzed by a magnetic spectrometer and detected by two counters in coincidence, a plastic scintillator front counter 0.010 in. thick and a potassium iodide back counter 0.090 in. thick. The measurements were experimentally normalized to obtain absolute differential cross sections. At each energy the differential cross section was measured at four different angles. The coefficients of the differential cross section $d\sigma/d\Omega^* = A + B \cos\theta^* + C \cos^2\theta^*$ and their errors were obtained by a least square fit to the measured points. (M.P.G.)

17083 MEASUREMENT OF THE POLARIZATION OF 16- AND 24-Mev NEUTRONS SCATTERED BY PROTONS. Walter Brenenson. Thesis, Madison, Wis., Univ. of Wisconsin, 1962. 64p.

The polarization in n-p scattering was deduced from measurements of the asymmetry in scattering of polarized, mono-energetic $T(d,n)He^4$ neutrons by protons. A solenoid and fast coincidence techniques were employed in the measurements. The polarization of the 16- and 24-Mev $T(d,n)He^4$ neutrons was measured using n-He^4 scattering as an analyzer. The analyzing power of the n-He^4 scattering was calculated using the phase shifts given by Seagrave. All the measured polarizations in n-p scattering have the same sign and range from 0.7% to 5.2%. The statistical errors of the measurements were on the average 2.5% in the polarization. The sign of the measured polarizations is consistent with the higher energy work at Harwell and calculations based on the phase shifts of Breit's group at Yale. Because these phase shifts gave polarizations higher than were observed at 24 Mev, an adjustment was applied to them by Breit's group. The resulting modified phase shifts fit well all the existing n-p scattering data from 13.7 to 350 Mev. (Dissertation Abst., Vol 23, No. 7)

17084 PHOTOPRODUCTION OF POSITIVE PIONS FROM HYDROGEN NEAR THRESHOLD. Richard Alfred Carrigan, Jr. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 195p.

The total cross section for photoproduction of positive pions from hydrogen near threshold was remeasured by detecting the decay positron from the π-μ-e. The total cross section was found to be fitted by: $\sigma = 4\pi\chi' \; 16.9 \times 10^{-30} \{(1 \pm .049) + (.960 \pm .149)\, v^2\}$ where $\chi' = \eta/k[1 + (\omega/E_\pi)]\,[1 + (k/E_\beta)]$. This cross section was used to obtain a value for the meson-nucleon coupling constant of $f^2 = .067 \pm .003$. The experimental cross section is compared to a theoretical form and found to be in some disagreement with it. In the experiment the photoproduced pions and their decay muons were stopped in a C absorber surrounding a H target. The μ decay positrons were detected in a thick counter telescope at a back angle to the target. A positron activation curve was obtained as a function of energy. The Modesitt least-squares technique was employed for final analysis of the activation curve. The effects of various parameters in the experiment are evaluated in some detail. A reasonable theoretical change in the shape of the bremsstrahlung distribution is found to cause a 7% change in the cross section at threshold. Energy errors are shown to be able to produce large cross section errors near threshold. Several analytical procedures are examined and found to give fairly consistent results. (M.P.G.)

17085 PROTON SPECTRA FROM THE P + D REACTION FOR 5-10 Mev INCIDENT PROTONS. Joseph Leonard Friedes. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 87p.

The proton spectra from the p + d → 2p + n reaction were measured at the 4 laboratory energies 10.62, 9.19, 6.97, and 5.53 Mev, and at the 2 laboratory angles, 14 and 34°. The proton beam from the University of Illinois cyclotron was used to bombard a deuterated polyethylene target. The breakup protons were recorded by a thin CsI scintillation counter used in conjunction with a magnetic spectrometer. All of the spectra have fewer low energy protons than would be predicted by phase space arguments alone. They all exhibit rather steep slopes near the maximum breakup energy, reaching $\frac{1}{3}$ to $\frac{1}{2}$ maximum height in less than $\frac{1}{4}$ of a Mev. The slope then decreases, the cross section rising to a maximum near $E/E_{max} = \frac{1}{2}$. Structure, in the form of a "knee" in the spectrum, has been observed near the maximum breakup energy for all the spectra with incident proton energies greater than 7 Mev. This structure becomes more pronounced as the scattering angle increases and less pronounced as the incident energy decreases. Similar structure has also been observed near the low energy end of the spectrum for the 10.6-Mev incident-proton energy. The only result that clearly emerges from comparisons between the theoretical and experimental curves is that no theory exists at the present time which gives the correct magnitude and shape of the observed spectra. (M.P.G.)

17086 NEUTRONS FROM D + T AND D + H. Carl Hugo Poppe. Thesis, Madison, Wis., Univ. of Wisconsin, 1962. 86p.

Measurements of the low-energy neutron spectra produced by bombarding tritium and hydrogen with deuterons have been made over a wide range of deuteron bombarding energies and neutron emission angles. The neutron spectra for tritium were observed at deuteron energies from ~5 to ~12 Mev at laboratory angles up to 70°. Spectra for hydrogen were observed at deuteron energies from ~7 to ~12 Mev at laboratory angles up to 20°. Deuterons were accelerated with a tandem electrostatic accelerator, and the neutron spectra were obtained using pulsed-beam time-of-flight spectrometry. After subtraction of backgrounds, the time-of-flight spectra were converted to energy spectra. In the energy range investigated, both deuteron breakup, T(d,np)T, and the $T(d,2n)He^3$ reaction can contribute to the continuous neutron spectrum from the deuteron bombardment of tritium. At 0° the observed spectra exhibit two maxima, one occurring at a neutron energy slightly below the maximum possible energy of neutrons from the breakup reaction, and the other occurring several Mev lower. Angular distributions of the d + T neutron spectra also exhibit the maxima seen at 0°, although the high-energy peak becomes less distinct as the angle increases. For d + H, only deuteron breakup, H(d,np)H, is possible and the resulting spectra vary smoothly with neutron energy. There is a tendency, however, for the spectra to peak at high neutron energies as the deuteron energy is increased. This peaking is interpreted as being caused by the onset of a final-state nuclear p-p interaction. (M.P.G.)

17087 NEUTRON POLARIZATION MEASUREMENTS USING A LIQUID HELIUM SCINTILLATING SCATTERER. Stephen Vallery Topp. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 63p.

The polarization of the high-energy ground-state group of neutrons from the $Li^7(d,n)Be^8$ reaction was measured, using deuterons of various energy provided by a Van de Graaff accelerator. These neutrons were scattered from a specially developed liquid-helium scintillating scatterer into right and left stilbene crystals, and the right-left asymmetry ratio was used to deduce the neutron polarization from the measured product of neutron polarization and helium analyzing power. The values of the He analyzing power used were those calculated by Levintov et al. A fast-slow coincidence requirement was used between the recoiling α particles in the liquid He and the right or left stilbene detectors, in order to ensure that the observed neutrons were from the ground state group, scattered first from the He and then into the detectors. At 29° lab. emission angle, the ground state $Li^7(d,n)Be^8$ neutron group exhibits a polarization which rises with deuteron bombarding energy to a value of approximately .12 to .018 at 1.1 Mev. At a bombarding energy of 1 Mev, the polarization increases from a value of zero at zero degrees to approximately .10 at 45° emission angle, and then becomes smaller at larger angles. (M.P.G.)

Neutron Physics

Refer also to abstracts 17456, 17457, 17459, 17460, 17461, 17463, 17465, 17467, 17468, 17469, 17471, and 17472.

17088 (BNL-770) THE THERMAL NEUTRON SCATTERING LAW AND NEUTRON THERMALIZATION. P. Schofield (Brookhaven National Lab., Upton, N. Y.). Oct. 1962. Contract [AT(30-2)-Gen-16]. 33p. (BNL-T-288)

The relation between the dynamics of the atoms of a moderating material and parameters considered important in the determination of thermal neutron spectra is discussed by considering a function that is the double Laplace transform of the symmetrized cross section $M(E)\sigma(E \rightarrow E')$ (where M(E) is the Maxwellian distribution at the temperature of the moderator). In particular the rate of energy exchange between a distribution of neutrons at one temperature and the moderator at another temperature is considered as giving a strong indication of the sensitivity of thermalization effects to details of the scattering law. (auth)

17089 (CRT-1088) THE SPHERICAL HARMONICS METHOD FOR THERMAL UTILISATION IN CYLINDRICAL CELLS. H. H. Clayton (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). May 1962. 40p. (AECL-1699)

Formulas are given for the spherical harmonics approximation, of arbitrary odd order, to the problem of one velocity neutron transport, with sources, in a multilayer cylindrical region with complete axial symmetry. The problem is reduced explicitly to the solution of a set of inhomogeneous linear equations for the moments in any one region at one of the interfaces. (auth)

17090 (GA-3298) ASYMPTOTIC SOLUTIONS OF THE TRANSPORT EQUATION FOR THERMAL NEUTRONS. Mark Nelkin (General Atomic Div. General Dynamics Corp., San Diego, Calif.). July 20, 1962. Contract AT (04-3)-167. 22p.

The eigenvalue problem defining the exponential time decay of a thermal neutron distribution is investigated. It is found that the decay constant is bounded whenever the neutron transit time is unbounded. For the particular case of spherical geometry, isotropic scattering, and a simple thermalization model, the fundamental mode decay constant reaches its upper bound for a finite sphere radius. This implies that there are no discrete eigenvalues of the thermal neutron transport operator for a sufficiently small sphere, in contrast to the result for mono-energetic neutrons obtained by Jörgens. The problem is first illustrated by reviewing the results for mono-energetic neutrons for a single Fourier component in an infinite medium, for a slab and for a sphere. Only the last of these has a bounded neutron transit time, and this also becomes unbounded when the possibility of zero velocity neutrons in a thermal neutron velocity distribution is considered. It is indicated, but not proved, that the conclusions drawn from the special model studied apply to more realistic models of slow neutron interaction with matter. The relevance to pulsed neutron experiments in small moderating samples is discussed. (auth)

17091 (LADC-5383) PROBABILITY DISTRIBUTION OF NEUTRONS AND PRECURSORS IN A MULTIPLYING ASSEMBLY. George I. Bell (Los Alamos Scientific Lab., N. Mex.). [1961]. Contract W-7405-eng-36. 81p.

The probability distribution of the number of neutrons and delayed neutron precursors in a multiplying assembly is considered. Particular emphasis is placed on the probability distribution for a system which is brought to a supercritical state in the presence of a neutron source which is so weak that deviations from the average population may be large. A space independent model is used with one group of neutrons. The problem is formulated in terms of the probability distribution generating function which satisfies a partial differential equation, which is derived. Its solution is attempted by the method of characteristics and general properties of the characteristic curves and the solution are discussed. The method is applied to a system without delayed neutrons, and, for a constant source, the generating function and probability distribution are found. The multiplication of precursors is treated in a short neutron lifetime model for a system which is below prompt critical. For a single group of precursors and constant reactivity, the generating function is derived. The short neutron life-time model is extended to a system above prompt critical, and again the generating function is found in a simple case. Calculation results are compared with experiments on Godiva and good qualitative agreement is shown. (auth)

17092 (TID-16485) ANALYSIS FOR DIFFUSION THEORY FLUX PEAKING AT A SHARP CORNER. J. H. Smith (Knolls Atomic Power Lab., Schenectady, N. Y.). June 22, 1962. Contract [W-31-109-eng-52]. 17p.

A formalism is given for determining monoenergetic diffusion theory flux peaking at a sharp corner. Advantage is taken of the special behavior of a Bessel function that seldom occurs in the literature. Specific (and simple) formulas are presented for the peaking, with quantitative guides for their mathematical accuracy when the formulae are known to be approximate. (auth)

17093 (TID-18117) SAIL. NAA Program Description. B. J. Lemke (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Feb. 1961. Contract [AT(11-1)-Gen-8]. 56p.

The NAA program, SAIL, was written in Fortran II for the IBM 709/90 to use the discrete S_n method for numerical solution of transient and steady-state neutron transport problems and to employ different techniques for data input and restarting a problem. The code is limited to 1 group, 100 regions, 100 intervals, plane geometry, and $n \leq 8$.

Instructions on how to use the program, a list of the routines and a flow chart or description of each, a description of the more important symbols used, and a listing of the program are included. (M.C.G.)

17094 (TID-18277) SCATTERING OF POLARIZED NEUTRONS. H. H. Barschall (Wisconsin. Univ., Madison). [1962]. Contract [AT(11-1)-Gen-7]. 27p.

Research performed during the last two years on the elastic scattering of polarized neutrons produced by nuclear reactions is reviewed. Techniques used in the experiments that included measuring polarization of neutrons before scattering, polarization as a function of scattering angle or element weight, and polarization from scattering by various nuclei at different energies (0.1 to 25 Mev) are described. 47 references. (D.C.W.)

17095 THERMAL NEUTRON SPECTRUM IN ABSORBING MEDIUM. A. Jannussis (Kernenergieabteilung der AEG, Frankfurt am Main). Atomkernenergie, 8: 52-3(Feb. 1963). (In German)

The solution of the Wigner-Wilkins integral equation for the thermal neutron spectrum is given in the form of a rapidly converging power series for the case where the scattering cross section is constant, and the absorption cross section has 1/v-dependence. (auth)

17096 NUMERICAL ANALYSES ON IBM-7090 OF RESONANCES DUE TO "s" NEUTRONS IN TIME-OF-FLIGHT TRANSMISSION EXPERIMENTS. G. Bianchi and C. R. Corge (Centre d'Etudes Nucléaires, Saclay, France). J. Phys. Radium, 23: 875-6(Oct. 1962). (In French)

A partial area method is given for the numerical analysis, using an IBM-7090, of "s" neutron resonances in time-of-flight experiments. The principle of this method is briefly reviewed, and the three steps in the analysis are described. (J.S.R.)

17097 ELASTIC LOW-ANGLE SCATTERING OF FAST NEUTRONS. Yu. V. Dukarevich and A. N. Dyumin (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 130-4(Jan. 1963). (In Russian)

The angular distribution of 14.2-Mev neutrons elastically scattered on W, Pb, Bi, Th, and U nuclei is investigated. An anomalous variation of the differential cross section in the low angle region has been found for Th and U. (auth)

17098 ANGULAR DISTRIBUTION OF THREE PARTICLES PRODUCED NEAR THE THRESHOLD. V. V. Anisovich and L. G. Dakhno (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 198-202(Jan. 1963). (In Russian)

The amplitude for production of three particles near the threshold is considered. The angular distribution of the produced particles is written down with an accuracy to terms quadratic in the particle momenta in the final state. The angular distributions in the reactions $\pi + N \rightarrow N + \pi + \pi$ and $K + N \rightarrow N + K + \pi$ are discussed. (auth)

17099 PACKING OF THE EXCITATION LEVELS OF LIGHT NUCLEI NEAR THE THRESHOLDS. V. I. Serov and V. A. Zhmailo. Zh. Eksperim. i Teor. Fiz., 44: 332-4 (Jan. 1963). (In Russian)

An analysis of available experimental data on excitation levels of light nuclei is carried out for the purpose of determining the correlation between the thresholds and levels. The excitation level density is found to increase near the thresholds. (auth)

17100 THE ASYMPTOTIC VALUES OF THE AMPLITUDES OF INELASTIC PROCESSES. K. A. Ter-Martirosyan (Inst. of Theoretical and Experimental Physics, USSR). Zh. Eksperim. i Teor. Fiz., 44: 341-54 (Jan. 1963). (In Russian)

A simple method is proposed for expanding the many-particle amplitude in relativistic theory in terms of partial waves. The expansions obtained are used for analyzing the asymptotic behavior of inelastic processes by the Regge and Gribov method. (auth)

17101 COMPARISON OF THE STRENGTH FUNCTIONS AND POLARIZATION OF NEUTRONS IN VARIOUS OPTICAL MODELS. Yu. P. Elagin. Zh. Eksperim. i Teor. Fiz., 44: 371-5(Jan. 1963). (In Russian)

Results of calculations for models with surface and volume absorption are compared. Strength functions for s and p waves and the polarization are calculated. It is shown that if the generally accepted potentials and parameters are employed, the discrepancy between the two models in the low energy region is not great. (auth)

17102 NEUTRON SOURCES AND THEIR CHARACTERISTICS. Technical Bulletin NS-1. Ottawa, Atomic Energy of Canada Ltd., [1956]. 28p.

A simplified summary of the theory and practical uses of neutron sources is presented. The many publications from which information was drawn are listed. (C.E.S.)

17103 APPLICATIONS OF INVARIANT IMBEDDING TO PROBLEMS OF NEUTRON TRANSPORT IN A SLAB. Glenn Raymond Ingram. Thesis, Pullman, Wash., Washington State Univ., 1962. 68p.

The problem of neutron transport in an infinite slab of finite width is treated from an invariant imbedding approach. A probabilistic treatment based on a collision-counting method is utilized to develop equations for the expected number of reflected and transmitted neutrons resulting from a single source neutron impinging upon the slab. An anisotropic and nonhomogeneous slab is considered, with certain results obtained for more restrictive assumptions. It is shown that the equations for the X- and Y- functions of Chandrasekhar can be obtained by this method, as well as the equation for the H function in the limiting semi-infinite case. Equations for the expected number of neutrons involved in a jth collision are derived. Through the use of a variable interior source, a computational scheme for the expected number of neutrons reflected and transmitted after a history of n collisions is established. The feasibility of numerical methods is discussed, and results of actual computations carried out on an IBM 709 are reported, with sample graphs included. (Dissertation Abst., Vol 23, No. 7)

Nuclear Properties and Reactions

Refer also to abstracts 16047, 16048, 16049, 16050, 16051, 16052, 16053, 16054, 17470, and 17473.

17104 (CRP-615(Rev.)) COEFFICIENTS FOR TRIPLE ANGULAR CORRELATION ANALYSIS IN NUCLEAR BOMBARDMENT EXPERIMENTS. A. J. Ferguson and A. R. Rutledge (Atomic Energy of Canada Ltd., Chalk River, Ont.). Feb. 1957. Revised and Reprinted Nov. 1962. 483p. (AECL-420)

The angular correlation between an incoming particle and two successive outgoing radiations can be expressed in terms of orthogonal functions of the three free angles. The coefficients of this expansion will be functions of quantized variables such as spins and orbital momenta and

of continuous variables such as matrix elements describing orbital and multipole mixtures. These coefficients for the case of a captured incoming particle followed by two outgoing gamma rays in cascade are presented. The coefficients greatly facilitate the computation of the theoretical results to compare with specific correlation experiments. (auth)

17105 (DESY-A-2.96) WIRKUNGSQUERSCHNITTE FÜR BREMSSTRAHLUNG UND PAARERZEUGUNG BEI HOHEN ENERGIEN. (Effective Cross Sections for Bremsstrahlung and Pair Production at High Energies). D. Lublow (Deutsches Elektronen-Synchrotron, Hamburg). Jan. 30, 1963. 54p.

Differential and integral cross sections for bremsstrahlung and pair production at high energies derived to three degrees of approximation are given. Formulas from Born's approximation for a pure Coulomb field are noted to be unreliable, but are used as a starting point for the other two treatments. In the next approximation the screening effect of atomic electrons is taken into account. The third approximation incorporates Coulomb corrections; and, finally, formulas containing both Coulomb and screening corrections are presented. Validity of the formulas is also discussed, and comparative graphs are included. (D.C.W.)

17106 (DP-817) RESONANCE INTEGRALS AND SELF-SHIELDING FACTORS FOR DETECTOR FOILS. Norman P. Baumann (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1963. Contract AT(07-2)-1. 52p.

Effective activation resonance integrals for thin and thick foils in an isotropic neutron flux were measured by a cadmium ratio method. Gold was used as a standard. Values obtained for dilute resonance integrals in barns, not including 1/v capture, were: Au^{197}, 1390 ± 40 (Reference); U^{238} capture, 280 ± 10; Cu^{63}, 3.17 ± 0.18; Cu^{65}, 1.39 ± 0.22; Mo^{98}, 9.9 ± 1.1; Mo^{100}, 4.06 ± 0.23; W^{186}, 476 ± 50; and Na^{23}, 0.075 ± 0.010. Dilute resonance integrals including 1/v capture above 0.60 ev were: U^{235} fission, 263 ± 9 and In^{115}, 3200 ± 100. These resonance integrals and the measured resonance flux self-shielding factors were generally in good agreement with calculations. However, the two isotopes of molybdenum appeared to have major contributions to their resonance integrals from nontabulated resonances. Special methods used with various foils are described. (auth)

17107 (GA-3069) ANALYSIS OF ACTIVATION MEASUREMENTS OF Th^{232} RESONANCE CAPTURES IN THE PEACH BOTTOM (40-MW(E) PROTOTYPE HTGR) CRITICAL ASSEMBLY. J. B. Sampson (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Sept. 14, 1962. Contract AT(04-3)-314. 76p.

Measurements of thorium resonance-capture activations relative to those of Au^{197}, which were made in the Peach Bottom (HTGR) critical assembly, are analyzed and compared with thorium resonance activations calculated from tabulated values of the resonance parameters. The new vanadium-subtraction method that was applied is shown to measure thorium resonance captures relative to those of Au^{197} to within several per cent in this geometry. The measurements show that the lowest several resonances of thorium capture less strongly than would be predicted by the listed parameters. This reduced capture is such that the thin-limit, epicadmium 1/E-spectrum resonance integral is about 84 b instead of the 96 b predicted by listed parameters; the thorium resonance captures for the critical assembly are about 6% less. The approximations currently used in calculating resonance captures in annular lattices probably underestimate captures by several per cent. The 300°K resonance-capture rate of ThO_2 in the annulus is indicated to be several per cent larger than that of metallic thorium, presumably because of a solid-state effect. 46 references. (auth)

17108 (ISS-62/21) SULL'ASSORBIMENTO DI MESONI π^- IN NUCLEI COMPLESSI. (On the Negative Pions Absorption in Complex Nuclei). G. Campos Venuti and G. Matthiae (Italy. Istituto Superiore di Sanità, Rome). May 30, 1962. 45p.

The existing experimental data on the absorption of negative pions in complex nuclei are presented and discussed in connection with the present theories and hypotheses. It is shown that further information is needed about the energy spectrum of the particles, particularly of the neutrons, emitted after absorption. The project and the experimental arrangement for measuring the energy spectrum of neutrons emitted in the energy range from about 1 to 50 Mev at the electron synchrotron in Frascati are described. 39 references. (auth)

17109 (ISS-62/27) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 300 Mev. (Kinematics of the Photoproduction from Hydrogen of Particles of 300 Mev Effective Mass). G. Campos Venuti (Italy. Istituto Superiore di Sanità, Rome). July 6, 1962.

Kinematical tables for the photoproduction from protons of a particle of 300 Mev effective mass were calculated for bombarding energies between 350 and 6000 Mev using the program A of the Report. ISS-IT 60/5. (auth)

17110 (ISS-62/28) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 400 Mev. (Kinematics of the Photoproduction from Hydrogen of Particles of 400 Mev Effective Mass.). G. Campos Venuti (Italy. Istituto Superiore di Sanita, Rome). July 10, 1962. 19p.

Kinematical tables for the photoproduction from protons of a particle of 400 Mev effective mass were calculated for bombarding energies between 500 and 6000 Mev, using the program A of the Report ISS-IT 60/5. (auth)

17111 (ISS-62/29) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 500 Mev. (Kinematics of the Photoproduction from Hydrogen of Particles of 500 Mev Effective Mass.). G. Campos Venuti (Italy. Istituto Superiore di Sanità, Rome). July 14, 1962. 15p.

Kinematical tables for the photoproduction from protons of a particle of 500 Mev effective mass were calculated for bombarding energies between 650 and 6000 Mev, using the program A of the Report ISS-IT 60/5. (auth)

17112 (ISS-62/30) CINEMATICHE DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 600 Mev, 900 Mev, 1000 Mev. (Kinematics of the Photoproduction from Hydrogen of Particles of 600 Mev, 900 Mev and 1000 Mev Effective Mass). G. Campos Venuti (Italy. Istituto Superiore di Sanità, Rome). July 1962. 30p.

Kinematical tables for the photoproduction from protons of particles of 600, 900, and 1000 Mev effective mass were calculated for bombarding energies between 800 and 6000 Mev using the program A of the Report ISS-IT 60/5. (auth)

17113 (JINR-E-1154) ON THE ACCURACY OF CALCULATIONS OF THE STRONGLY DEFORMED ELEMENT PROPERTIES USING THE SUPERFLUID NUCLEAR

MODEL. M. K. Volkov, A. Pavlikovskii (Pavlikovsky), B. Rybarska, and V. G. Solovev (Soloviev) (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 19p.

The accuracy of calculations according to the superfluid nuclear model was investigated on the basis of a model with five levels, which permits an exact solution on the electronic computer. Comparison was made with the real case of a system consisting of 102 neutrons. The investigation showed that the accuracy of calculations is in the main restricted to the uncertainties in the details of the average field and the fluctuation in these single-particle levels but not to the inaccuracy of the mathematical method used. (auth)

17114 (JINR-P-1148) OPREDELENIE VYKHODOV NEKOTORYKH OSKOLKOV PRI DELENII TYAZHELYKH YADER MNOGOZARYADNYMI IONAMI. 2. DELENIE U^{238} IONAMI Ne^{22}. (Yields of Some Fragments in Bombardment of Heavy Nuclei with Multicharged Ions. II. Fission of U^{238} by Ne^{22} Ions). I. Brandshtetr, I. Zvara, T. Zvarova, V. Kioblokh, M. Krzhivanek, Ya. Maly, and Su Hung-Kuei (Joint Inst. for Nuclear Research Dubna, U.S.S.R. Lab. of Nuclear Reactions). 1962. 11p.

The yields of fission products from U^{238} bombardment with Ne^{22} ions were determined in the region of mass numbers 72 to 179, and the curve of the charge distribution was plotted. A new isotope, Tm^{173}, with half life 7.8 + 0.5 hr and gamma energy E = 0.40 ± 0.02 Mev was found. (auth)

17115 (JINR-P-1153) OB UPRUGOM RASSEYANII TYAZHELYKH IONOV. (On Elastic Scattering of Heavy Ions). S. P. Ivanova and B. N. Kalinkin (Joint Inst. for Nuclear Research Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 7p.

A more detailed treatment is given the elastic scattering of heavy ions in the quasi-classical approximation. The smoothness of switching on of the absorption is taken into account. The diffraction maximum observed in experiment is reproduced. Additionally, it is established that the curve corresponding to the ratio of the cross section of elastic scattering to that of the Rutherford scattering for strictly fixed energy can have a fine structure. (auth)

17116 (JINR-P-1157) POISKI VTORICHNYKH REAKTSII ZAKHVATA DEITERIYA I TRITIYA. (Search for Secondary Reactions of Deuterium and Tritium Capture). Chuang-peng Wang, V. N. Mekhedov, V. N. Rybakov, and R. A. Szymczak (Joint Inst. for Nuclear Research Dubna, U.S.S.R. Lab. of Nuclear Problems). 1962. 8p.

The yields of heavy arsenic isotopes from irradiation of germanium with 120, 300, 480, and 600 Mev protons were determined by a radiochemical method. With increasing proton energy the yields fall monotonously and are within 3.4–1.0 mb for As^{74}, 1.0–0.38 mb for As^{76}, and 0.13–0.035 mb for As^{77} and As^{78}. The initial (p,xn) reactions are likely to be the production mechanism of As^{74} and As^{76}. As^{78} is generated, apparently, by capturing the over-Coulomb tritium nuclei. The origin of As^{77} is more complicated. At low proton energies (120 and 300 Mev) it is produced, in the main, from secondary reactions in which deuterium and tritium nuclei are captured. At higher proton energies the major part of this isotope is probably obtained from the secondary reactions of α-particle capture. 28 references. (auth)

17117 (JINR-P-1160) UGLOVOE RASPREDELENIE I POLYARIZATSIYA YADER OTDACHI PRI ZAKHVATE CHASTICHNO POLYARIZOVANNYKH μ^- MEZONOV. (Angular Distribution and Polarization of Recoil Nuclei in the Capture of Partially Polarized μ^- Mesons). G. Ya. Korenman and R. A. Eramzhyan (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 12p.

General formulas for the angular distribution and for the polarization of recoil nuclei in the capture of partially polarized μ^- mesons were obtained for the unique and non-unique $0 \rightarrow J$ transitions. The results are expressed in terms of the Morita–Fujii nuclear matrix elements. The calculation of the polarization of the B^{12} ground state in the muon capture on C^{12} was made for different values of the induced pseudoscalar constant and weak magnetism. (auth)

17118 (JINR-P-1162) SECHENIE OBRAZOVANIYA KOMPAUND-YADRA V REAKTSIYAKH S UCHASTIEM TYAZHELYKH IONOV. (Cross Section for Compound-Nucleus Formation in Reactions Involving Heavy Ions). S. P. Ivanova and B. N. Kalinkin (Joint Inst. for Nuclear Research Dubna, U.S.S.R. Lab. of Theoretical Physics). 1962. 9p.

The compound-nucleus formation cross sections are calculated for a number of reactions. Information on parameters of nuclear interaction obtained from the quasi-classical analysis of experiments on heavy ion elastic scattering is used. The account of such an interaction is established to be important. (auth)

17119 (JINR-P-1164) POISKI RADIATSIONNYKH RASPADOV REZONANSNYKH SASTOYANII. (Search for Radiative Decays of Resonance States). V. B. Lyubimov, Mu-tsung, M. I. Podgoretskii, S. I. Portnova, V. N. Streltsov, and Z. Trka (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of High Energy). 1963. 11p.

From analysis of the energy spectra of γ quanta produced in π^-–N and π^-–C interactions at E_π = 7 Bev, the conclusion is drawn that there exists a radiative decay of an η meson. Preliminary results of the search for the radiative decays via the schemes $x_1 \rightarrow \pi^+ + \pi^- + \gamma$ and $x_2 \rightarrow \pi^0 + \gamma$ are reported. (auth)

17120 (LAL-1029) ETUDE DE LA DIFFUSION D'ELECTRONS DE 150 Mev SUR L'OXYGENE 18. (Study of the Scattering of 150-Mev Electrons by Oxygen-18). F. Lacoste (Paris. Université, Orsay. École Normale Supérieure. Laboratoire de l'Accélérateur Linéaire). Apr. 1962. 113p.

The scattering of 150-Mev electrons by O^{18} was used to obtain new data on the charge distribution and the excited levels of this nucleus. The measurement equipment is described in detail with emphasis on the analysis system and the electron detection system. A detailed study is then made of the different electron interactions in the target and of the convolution of the corresponding energy distributions. This study permitted a precise evaluation of the electromagnetic corrections for the experimental conditions chosen. The results of the measurement of the elastic and inelastic scattering on O^{18} were reported. These results show a very important difference between the form factors of O^{16} and O^{18}. The principal characteristics of the excitation of the first levels of O^{18} can be determined. The experimental results are compatible with different nuclear models, particularly with the hypothesis of a spherical nucleus and that of a deformed nucleus. (J.S.R.)

17121 (LNF-62/102) ALCUNI METODI DI POLARIZZAZIONE MAGNETICA DEI NUCLEI. (Some Methods of Magnetic Polarization of Nuclei). Note No. 171. V. Montelatici (Italy. Comitato Nazionale per l'Energia Nu-

cleare. Laboratori Nazionali, Frascati). Dec. 5, 1962. 24p.

Some methods for the alignment along a predetermined direction of the nuclear magnetic moment are reported with particular emphasis on the dynamic polarization methods. With this last method, high orientation percentages can be attained (50% in some paramagnetic salts), even when the sample is kept at a relatively high temperature (at one degree Kelvin) and exposed to not excessively high static magnetic fields (10 to 20 kgauss). (tr-auth)

17122 (PUC-1962-78) SCATTERING OF HIGH ENERGY DEUTERONS BY COMPLEX NUCLEI. Larry Zamick (Princeton Univ., N. J. Palmer Physical Lab.). July 6, 1962. Contract AT(30-1)-937. 44p.

Making use of the high energy approximation developed for quantum mechanical scattering problems largely by Glauber, the theory of the scattering of high energy deuterons by complex nuclei was considered. The optical potential describing this process was constructed in terms of the nucleon-nucleon scattering amplitude. This potential contains a central, spin-orbit, and tensor terms. A calculation was made of the angular distribution, the vector and tensor polarizations for the scattering of 420 Mev deuterons by carbon and compared with the experimental data of J. Button and R. Mermod. Disagreement is noted for the tensor polarization. (auth)

17123 (TID-18127) SUMMARY OF PROGRESS REPORT [ON NUCLEAR PHYSICS], DURING YEARLY PERIOD ENDING IN FEBRUARY 1963. (Yale Univ., New Haven). Contract AT(30-1)-1807. 17p.

Aspects of nucleon-nucleon interactions are being examined. Tests of the mathematical form of the one-pion exchange interaction and of the validity of charge independence were improved. No real negation of the applicability of either the mathematical form of the one-pion exchange potential or of charge independence has been found. Work on p-p and p-n scattering analysis centered on improving the accuracy of data and on rewriting IBM 704 programs for the IBM 709 and 7090. The new programs provide separate treatments of errors in quantities such as differential cross sections and in relative values at the same incident energy. Improvements in the least squares method of adjustment to data were also made. Difficulties in correcting for the effects of nuclear magnetic moments were examined, and formulas and numbers giving the corrections applicable to the one-pion exchange group were worked out and incorporated in new machine programs. A partial analysis of data for n-p scattering in the 2 to 3 Bev energy region shows the existence of a sharp peak in the angular distribution of recoil protons from elastic collisions. Interpretation of work on the interplay of multipion resonance effects with each other and with the direct pion interaction was begun. Systematization of spin rotation effect and aspects of relativistic effects in the Coulomb interaction in p-p scattering was carried out. Treatment of N-N spin-orbit and central field interactions caused by vector meson exchange was improved. Programming of the IBM 709 for computation of the first order nucleon-nucleus optical potential and nucleon-nucleus observables in first Born approximation at forward angles from N-N phase parameters was performed. An IBM 709 program for computing π-N scattering observables from phase shifts was also written. Investigation of photodisintegration of deuterons involved correcting the formulas used in calculating higher order magnetic multipole effects for some omitted effects and rewriting the 704 programs for the IBM 709. Progress in a scattering matrix approach to deuteron photodisintegration was also made. In theory of nucleon-transfer reactions, systematization of the connection between completely quantum mechanical and semi-classical treatments, including analysis of approximations required in the former to obtain the latter, was attempted. Presence of interference effects between the waves was partially confirmed by experiment. Calculations of third order effects in Coulomb excitation were carried out, and programming for more extensive work was begun. Work on interpretation of heavy ion elastic scattering involved additional calculations of the interaction using nucleon-nucleus scattering with some calculations using an ingoing wave boundary condition instead of an optical model treatment of the nuclear interior. Twenty-one papers published or submitted for publication during the period are listed. (D.C.W.)

17124 (TID-18131) THE FISSION OF THORIUM AND RHENIUM INDUCED BY INTERMEDIATE ENERGY HELIUM IONS (thesis). Marshall E. Davis (Purdue Univ., Lafayette, Ind.). Jan. 1963. Contract AT(11-1)-347. 167p.

The fission of natural thorium by helium ions with energies from 20 to 40 Mev was studied using radiochemical determination of the absolute yields of several fission products. A small symmetric peak was observed in the valley of the generally asymmetric mass-yield curve, and evidence for fine structure was noted in the valley and light peak regions. Neutron yield/fission was also found lower than in previous reports. The valley to peak ratios from fission of the U^{236} compound nucleus are higher than those reported for the fast-neutron-induced fission of U^{235} for the same excitation energies, perhaps due to differences in angular momentum. Limited independent data on Br^{83} and La^{140} are in fair agreement with the constant charge ratio rule proposed for heavy element fission at intermediate energies. Data from similar work on natural rhenium shows the mass yield curve at 40 Mev to have a symmetric peak about A = 93 with a width at half weight of 20 mass units. For incident energies down to 35 Mev the cross sections drop more rapidly than previously reported. Neutron yield/fission appeared to be 3 to 4. 127 references. (auth)

17125 (TID-18137) STUDY OF POLARIZATION FROM REACTIONS. W. Haeberli (Wisconsin. Univ., Madison). [1963]. Contract AT(11-1)-Gen-7. 28p.

Measurements of the degree of neutron polarization from the reactions $D(d,n)He^3$, $T(p,n)He^3$, $T(d,n)He^4$, $Li^7(p,n)Be^7$, $Be^9(p,n)B^9$, $Li^7(d,n)Be^8$, $N^{14}(d,n)O^{15}$, and $C^{12}(d,n)N^{13}$ at various energies are presented and compared. Dependence of polarization on the angle and bombarding energy is also examined. (D.C.W.)

17126 (TID-18165) A FISSION STUDY OF U^{235} AND U^{238} (thesis). Sheldon Henry Freid (Purdue Univ., Lafayette, Ind.). Jan. 1963. Contract AT(11-1)-347. 42p.

An investigation was undertaken to resolve the valley or symmetric region of the mass yield curves of U^{235} and U^{238} with intermediate energy helium ions. The results verified the existence of a third peak in the symmetric region of the mass yield curve of U^{235}; however, the U^{238} curve did not show this peak. Correlation with various fission parameters seems to indicate a transition from single to triple to double peaked mass yield curves rather than a competition between two separate and independent modes of fission. 41 references. (auth)

17127 (TID-18256) POLARIZATION OF NEUTRONS FROM THE $N^{14}(d,n_0)O^{15}$ REACTION AT 1.32 Mev (thesis). Harold Morton Epstein (Ohio State Univ., Columbus). 1962. Contract [AT(11-1)-605]. 90p.

The $N^{14}(d,n)O^{15}$ reaction was studied to obtain information on the interaction mechanism, to look for information about states in O^{16} above 20 Mev excitation, and to consider the reaction's value as a source of polarized neutrons. Theory of polarization is discussed, particularly polarization in direct and compound nucleus reactions. Methods for measuring polarization are reviewed, and the technique used in the study is described. Polarization is experimentally determined by measuring the left-right symmetry in scattering from a liquid helium analyzer. Details of the experimental arrangement and technique are also presented. The results are examined in connection with similar efforts by other workers. Calculations of the cross section and polarization were made on the basis of both direct interaction and compound nucleus processes for the reaction. Efforts to explain the data in terms of a reaction proceeding through the O^{16} compound nucleus with only 2 levels important indicate the presence of either a 1^- level or a 3 level scheme with two levels of odd parity. Total reaction cross section calculations based on a stripping process gave values too high at 1.32 Mev. Polarization calculations gave a sign and shape for the forward angle polarization in approximate agreement with experiment, but with magnitude too small. At a deuteron energy of 1.32 Mev, the reaction was found to produce partially polarized neutrons, and both direct and compound nucleus interaction theories predict high polarizations at some angles and energies. At the energies utilized, the compound nucleus model apparently describes the reaction while the direct interaction model does not explain the experiments. 84 references. (D.C.W.)

17128 (UCRL-6695) FISSION DISTRIBUTION IN SEVEN-PIN CLUSTER FUEL ELEMENTS. Robert Gordon (California. Univ., Livermore. Lawrence Radiation Lab.). Sept. 1962. Contract W-7405-eng-48. 225p.

The distribution of fissions within one fuel pin of a cluster is asymmetrical because of self-shielding and neutron streaming phenomena. An implicit solution of the integral form of the Boltzmann equation indicates that, for a given neutron spectrum, this distribution is primarily a function of three dimensionless parameters: pin radius/neutron mean free path in pin material, pin circle radius/pin radius, pin radius/fuel element radius. The actual distribution was determined experimentally by detector foils and autoradiographic techniques for various seven pin, cluster type, gas-cooled fuel elements. The experimental fuel pins were fabricated by winding alternate 0.001 inch thick layers of pure aluminum and enriched uranium (93% U^{235}) on a solid core until the desired pin diameter was reached. Seven of these pins, assembled into a fuel element, were irradiated in the thermal column of a research reactor. The layers of uranium and the uranium detector foils (which had been exposed concurrently) were subsequently autoradiographed and the resulting x-ray film optical density measured on a microdensitometer. The detector foils were also counted in a gamma detector, thus providing a key between relative radioactivity and optical density. The fission distribution within the center pin of the cluster was found symmetrical and could be represented by $D = D_1 \exp [C_1(x^2 + y^2)]$. The fission distribution in the outer pins of the cluster was asymmetrical with respect to the pin center but could be represented by $D = D_2 \exp [C_2(x^2/g^2 + (y - y_0)^2)]$. Values of the constants in the above equations are correlated by the first two dimensionless parameters given above but appear to be independent of the third. Data and values of constants and parameters are given. 37 references. (auth)

17129 (UCRL-6926) THE FISSION CROSS SECTION OF U^{235}. C. D. Bowman, G. F. Auchampaugh, and S. C. Fultz (California. Univ., Livermore. Lawrence Radiation Lab.). June 15, 1962. Contract W-7405-eng-48. 35p.

The fission cross section of U^{235} was investigated with high resolution between 0.03 and 60 ev using the neutron time-of-flight facility at the Livermore linear electron accelerator. Normalization of the relative cross sections in the thermal region indicates that the fission cross sections generally accepted are about 20% too large in the region between 5 and 60 ev. Values for the resonance parameters $\sigma_0\Gamma_f$ and Γ_f above 5 ev are compiled and are compared with similar measurements by other investigators. Evidence is also presented that indicates that the fission widths fall into two groups corresponding to the two total angular momenta involved in the reaction. (auth)

17130 (UCRL-10630) THE INFLUENCE OF HIGH PRESSURES ON THE MÖSSBAUER EFFECT IN DYSPROSIUM-161 (thesis). John A. Stone (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 17, 1963. Contract W-7405-Eng-48. 70p.

Nuclear resonance absorption of the 25.6-kev gamma ray of Dy^{161} was studied experimentally at pressures up to 100 kbar by using sources situated in gadolinium metal together with thin metallic dysprosium absorbers. Velocity spectra taken at 30 and 50 kbar show complex hyperfine structure. Increasing the pressure leads to both greater recoil-free fractions and greater overall hyperfine splitting. The effect of pressure on the recoil-free fraction is satisfactorily explained with a modification of Hanks' theoretical treatment. It is proposed that the hyperfine splitting is predominantly due to electric quadrupole interactions, with the electric field gradient at the nucleus increasing with increasing pressure. By fitting theoretical spectra to the velocity spectrum at 30 kbar, a value of 1.30 is derived for the ratio of the quadrupole moments of the 25.6-kev state and the ground state of Dy^{161}. 64 references. (auth)

17131 DETERMINATION OF THE MAGNETIC MOMENT OF PLUTONIUM-239. Simon Gerstenkorn (Centre National de la Recherche Scientifique, Paris). Ann. Phys. (Paris) (13), 7: 405-14(July-Aug. 1962). (In French)

The Goudsmit-Fermi-Segré relationship connecting the magnetic moment μ to the interval factor $\underline{a}_{ns}$ of the $\underline{ns}$ electron permits, in particular, the evaluation of the nuclear magnetic moment of Pu^{239} if the interval factor $\underline{a}_{7\underline{s}}$ of the $7\underline{s}$ electron can be determined in this case. The interval factor $\underline{a}_{7_1}$ was evaluated from the hyperfine structure of the Pu II rays, and the value of the magnetic moment thus deduced was equal to $+0.21 \pm 0.06\ \mu_N$. The arrangement of the components makes it possible to state that the magnetic moment is positive, whereas the theoretical value given by B. R. Mottelson and S. Nillson is negative and equal to $-0.1\ \mu_N$. The value found $+0.21\ \mu_N$ differs by a factor of 10 from that given by Hubbs et al. ($\pm 0.02\ \mu_N$). This last value calculated from the hyperfine structure of the $^7F_1$ level of Pu I (studied by magnetic resonance) rests on the hypothesis that the coupling is LS: but, the fine and hyperfine structures of the $^7F_{0-6}$ show that this hypothesis must be rejected. The value of the magnetic moment calculated from the interval factor $\underline{a}_{7_1}$ is, in principle, independent of the coupling mode. The value proposed is found in the region of uncertainty given by

Bleaney et al. ($\pm 0.4 \pm 0.2\ \mu_N$) obtained by magnetic resonance. (tr-auth)

17132 QUANTUM THEORY OF THE OPTICAL PUMPING CYCLE. EXPERIMENTAL VERIFICATION OF NEW EFFECTS PREDICTED. C. Cohen-Tannoudji (Laboratoire de Physique de l'École Normale Supérieure, Paris). Ann. Phys. (Paris) (13), 7: 423-60(July-Aug. 1962). (In French)

A detailed physical interpretation of the results of the Barrat-Cohen-Tannoudji theory of the optical pumping cycle is presented. The experimental verification of the essentially new effects that the calculation of the pumping cycle predicts is described. The odd isotopes of mercury were chosen for the experimental verification. The two most important effects predicted by the theory and verified by the experimental work are the radiative effects associated with the absorption process and the partial conservation of "coherence" during the optical pumping cycle. (J.S.R.)

17133 ON THE DERIVATION OF ASYMPTOTIC EXPANSIONS OF EXPONENTIAL INTEGRALS, WITH APPLICATIONS TO COULOMB EXCITATION FUNCTIONS. P. J. Brussaard, T. A. Griffy, and L. C. Biedenharn (Duke Univ., Durham, N. C.). Ann. Physik (7), 10: 47-59(1962). (In English)

The Coulomb excitation process has received considerable attention recently. The electric (and magnetic) interaction between the projectile and the target nucleus can be decomposed into multipole components, and the semiclassical treatment of this process was found to lead to very accurate results. The excitation probability of the various multipole transitions is calculated by first order time-dependent perturbation theory, with the relevant matrix elements appearing as path integrals along the hyperbolic orbit of the projectile in the Coulomb field of the target nucleus. A second integration over all possible impact parameters (or equivalently over all possible orbital eccentricities) then yields the excitation probability. It is only in the electric dipole (E1) case that these integrations can be performed analytically. (auth)

17134 CONCERNING THE DEFORMATION ALTERATION OF NUCLEI BY ROTATION. Ingrid Rotter (Inst. for Nuclear Physics, Academy of Sciences, Berlin). Ann. Physik (7), 10: 153-6(1962). (In German)

By rotation the deformation in the ground state of slightly deformed nuclei is increased so that the pair reciprocal effects of the nucleons are reduced. The deformation of strongly deformed nuclei is not greatly changed. (tr-auth)

17135 ON INVESTIGATION OF PRIMARY NUCLEAR REACTIONS INSIDE THE CYCLOTRON CHAMBER. A. Papkow and E. Pietsch (Max-Planck-Institut für Kernphysik, Heidelberg). Ann. Physik (7), 10: 201-6(1962). (In German)

For analysis of the secondary products of nuclear reactions the cyclotron magnetic field was used. Targets were on a radially adjustable probe so that the primary energies could be varied through wide limits. For detection of reaction products inside the cyclotron chamber nuclear photoplates were used. (tr-auth)

17136 THE ELECTRON CAPTURE DECAY OF Er^{165}. Hans Ryde, Lars Persson, and Karin Oelsner-Ryde (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 23: 171-86 (1963). (In English)

The electron and gamma ray spectra from the electron capture decay of Er^{165} to Ho^{165} were studied. The half-life of this decay was determined to be 10.34 ± 0.05 h. From a comparison of the weak internal bremsstrahlung spectrum with the theoretical distribution, a total decay energy of 370 ± 10 kev was deduced. Log ft = 4.61 ± 0.02 is calculated for the transition to the ground state of Ho^{165}, which is in agreement with the value expected for an unhindered, allowed transition and supports the classification 5/2 − [523] for the ground state of Er^{165}. Consistent with the classification of the known states, no transitions to excited levels in the daughter nucleus were observed. It was possible to record the pure K Auger electron spectrum of holmium. The relative intensities of the partially resolved K Auger groups are given. (auth)

17137 IRREGULAR VIBRATION SPECTRA OF SPHERICAL EVEN-EVEN NUCLEI. M. Demeur (Universite, Libre, Brussels). Bull. Classe Sci., Acad. Roy. Belg., (5) 48: 453-9(1962). (In French)

A phenomenological potential is proposed in order to explain the anomalous vibrational spectra of spherical nuclei with energy ratio E_4'/E_2 smaller than 2. A correlation between this anomaly and shell closure is noted. (auth)

17138 TWO-HOLE TWO-PARTICLE LEVELS IN Pb^{208}. William T. Pinkston (Vanderbilt Univ., Nashville) and William W. True. Can. J. Phys., 41: 478-83(Mar. 1963).

The energy levels of Pb^{208} arising from certain two-hole, two-particle shell-model configurations were predicted theoretically. It is concluded that only a few such levels are expected in Pb^{208} and all of them have energies greater than or about equal to 6 Mev. The closed-shell core was included in the $J = 0^+$ energy matrix in order to get an estimate of the two-body correlations in the ground state. Only a few per cent of higher configurations is predicted for the ground-state wave function. (auth)

17139 THE CROSS SECTION FOR THE $Ni^{58}(n,\alpha)Fe^{55}$ GROUND-STATE TRANSITION. W. G. Slinn and J. M. Robson (Univ. of Ottawa). Can. J. Phys., 41: 545-6(Mar. 1963).

It was shown that (n,α) cross section measurements may be possible from an experimental point of view. A one mg/cm^2 natural nickel target was used and a solid-state junction counter served as a detector. Two proportional counters were placed between the target and the alpha detector and were used to gate the channel analyzer that recorded the alpha spectrum. The cross section for the $Ni^{58}(n,\alpha)Fe^{55}$ ground state transition at 14.7 Mev was found to be 1 ± 0.3 mb. (C.E.S.)

17140 OBSERVABLE REORIENTATION EFFECTS IN HEAVY-ION COULOMB EXCITATION. D. Beder (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. J. Phys., 41: 547-9(Mar. 1963).

It is shown that the reorientation effect for the first excited states of such nuclei as Fe^{56}, Ti^{46}, and Mg^{24} is large enough to permit measurements of the quadrupole moments of these states. The effects appear to be larger for the differential excitation cross section than for the angular distribution of gamma rays following Coulomb excitation. To obtain this result, computer calculations were performed of cross-section and angular-distribution expressions from previous work. (C.E.S.)

17141 NEW ISOMERS IN ANTIMONY AND IODINE. A. C. Ghosh and W. M. Martin (McGill Univ., Montreal). Can. J. Phys., 41: 550-4(Mar. 1963).

The elements yttrium, niobium, antimony, and iodine were bombarded in the external beam of the McGill 100-Mev proton synchrocyclotron. In each case an isomeric state was found to result from the proton reactions. The associated γ radiation was studied using a single NaI(Tl)

crystal, a 256-channel TMC kicksorter, and a 17-channel time analysis system. (C.E.S.)

17142 A NOTE ON THE 2320-Kev LEVEL IN Zn^{68}. H. W. Taylor and R. McPherson (Univ. of Alberta, Edmonton and McGill Univ., Montreal). Can. J. Phys., 41: 554-61 (Mar. 1963).

The decay of Ga^{68} was studied using scintillation coincidence spectrometers. Gamma rays with the following energies were observed: 510, 800 ± 10, 1077 ± 3, 1255 ± 10, 1870 ± 10, and 2320 ± 20 kev. The 1870 and 2320 kev radiations were identified as crossover transitions to the ground state of Zn^{68}. The 2320 kev crossover transition was sought using a scintillation counter placed in a low background environment. (C.E.S.)

17143 DETERMINATION OF THE ENERGIES OF INTENSE α GROUPS EMITTED BY THE NUCLEI OF PLUTONIUM-238, 239, 240 AND NUCLEI OF AMERICIUM-241. Chin-Fan Leang (Centre de Spectrometrie Nucleaire et de Spectrometrie de Masse, Orsay, France). Compt. Rend., 255: 3155-7(Dec. 5, 1962). (In French)

The energies of the intense α rays of Pu^{238}, Pu^{239}, Pu^{240}, and Am^{241} were determined by magnetic spectroscopy with respect to Bi^{212} with a precision of 1/7000. (J.S.R.)

17144 STUDY OF THE ELECTRON DECAY OF BERYLLIUM-9. Hoan Nguyen Ngoc and Jean Perez y Jorba (Ecole Normale Superieure, Orsay, France). Compt. Rend., 255: 3158-60(Dec. 5, 1962). (In French)

A method for the determination of the cross sections of the electron decay for all excitation energies, all transfers of motion quantity, and all scattering angles between given experimental limits was taken to completion in the first Born approximation and applied to the case of Be^9. Form factors associated with excitation energies between 17 and 49 Mev were deduced. The multipolarity, the electronic or magnetic character of the associated transitions, and the radiative lengths associated with these transitions were determined. (tr-auth)

17145 (n,α) REACTIONS ON THE NUCLEI OF SILICON-28 AND 29 FOR 13.4 AND 13.8 Mev NEUTRONS. Daniel Didier, Éric Fort, and Pierre Thouvenin. Compt. Rend., 256: 124-6(Jan. 2, 1963). (In French)

The energy spectra from (n,α) reactions of Si^{28} and Si^{29} were determined and shown graphically. The agreement between experimental and theoretical values for the sum of the energies in Mev of the α particle and of the recoil nuclei for Mg^{25} and Mg^{26} are good. (J.S.R.)

17146 PROBABILITIES OF RADIATION TRANSITIONS IN ODD AND ODD-ODD DEFORMED NUCLEI. I. ASYMPTOTIC CONCEPT OF NUCLEAR STATE IN DEFORMED NUCLEI. M. E. Voikhanskii. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 118-24(Jan. 1963). (In Russian)

Radiation transitions in odd nuclei are studied using deformed nuclear internal wave functions, $\chi_{N\Omega}$, expanded by intrinsic anisotropic harmonic oscillator functions, $\Psi_{n_z n_p \Lambda \Sigma}$, which are simpler than Nilsson functions. Moreover, the calculations engage selection rules according to asymptotic quantum numbers: N, n_z, Λ, and Σ. A single-particle transition of EL multiplicity from the state described by quantum numbers: $I_i, \Omega_i = K_i, \pi_i, N_i, n_{zi}, \Lambda_i$, and Σ_i into the state $I_f, \Omega_f = K_f, \pi_f, N_f, n_{zf}, \Lambda_f$, and Σ_f was analyzed. In odd-odd deformed nuclei the unpaired nucleons are considered independent functions, and each of the unpaired nucleons was correlated to a set of quantum numbers: Ω_p, N_p, n_{zp}, Λ_p, Σ_p, and Ω_n, N_n, n_{zn}, Λ_n, and Σ_n. Two Ω values are possible for odd-odd nuclei: $\Omega = \Omega_p + \Omega_n$ and $\Omega = |\Omega_p - \Omega_n|$, respectively, for parallel and non-parallel orientation of unpaired nuclear projection moments. (R.V.J.)

17147 ISOMERIC TRANSITIONS IN EVEN-EVEN NUCLEI WITH HALF LIFE 10^{-4} TO 10^{-1} sec. V. V. Remaev, Yu. S. Korda, and A. P. Klyucharev (Inst. of Physics and Tech., Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 125-31(Jan. 1963). (In Russian)

An attempt was made to determine the multiplicities and types of isomeric γ transitions in the even-even deformed nuclei: Ce^{138*}, Nd^{140*}, and W^{180*}. The isomers were produced by reactions with fast protons in a linear accelerator at 20.8 Mev, set up for activities at 10^{-4} sec < $T_{\frac{1}{2}}$ < 10^{-1} sec. The isomeric transition at 300 kev in Ce^{138*} (produced by $La^{139}(p,2n)Ce^{138}$), with 0.3, 0.8, and 1.04-Mev γ lines and $T_{\frac{1}{2}} = 9.2 \times 10^{-3}$ sec, is considered as a magnetic quadrupole scheme. The conversion electron peak for Nd^{140*} (produced by $Pr^{141}(p,2n)Nd^{140}$), with $T_{\frac{1}{2}} = 0.6 \times 10^{-3}$ sec and 1.00, 0.77, and 0.435-Mev γ lines, was found at 435 kev with a total conversion coefficient $\alpha = 0.08 \pm 0.02$. The isomer W^{180*} (produced by $Ta^{181}(p,2n)W^{180}$) with $T_{\frac{1}{2}} = 5.5 \times 10^{-3}$ sec and γ lines at 0.22, 0.35, and 0.5 Mev, had a complex spectrum. An electron conversion peak for W^{180*} was found only for α_K at 150 kev. (R.V.J.)

17148 BETA STABILITY OF HEAVY ELEMENTS. N. N. Kolesnikov, A. P. Krylova, and V. K. Kandybarov. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 132-6(Jan. 1963). (In Russian)

An attempt was made to demonstrate that β decays (including various permissible transition levels) vary quite regularly in the limited regions of heavy nuclei (Z > 87, N > 133) where deformations are almost identical. The logarithm of total β decay, lg τ_{β^-}, for (A,Z) drops linearly with the rise of lg(Z to Z_{β^-}); a similar regularity was observed for electron capture. Magnitudes of Z_{β^-} (and Z_e) for four types of parity were calculated by linear interpolation of Q_{β^-} (Q_e), and the Z_{β^-} and Z_e curves were constructed. (R.V.J.)

17149 NEW DATA ON THE FORMATION MECHANISM OF LIGHT NUCLEI. A. K. Lavrukhina, L. P. Moskaleva, and R. I. Kuznetsova. Izv. Akad. Nauk SSSR, Ser. Fiz., 27: 137-40(Jan. 1963). (In Russian)

The formation cross sections and angular and energy distributions of Na^{24} from proton reactions with Al, Ag, and W at 660 Mev were studied. Formation cross sections and angular distributions of F^{18}, Na^{24}, and P^{32}, from Sb, Sn, and U were also measured at E_p = 120 Mev in order to determine the energy dependence. The results showed that the formation cross sections for Be^7, F^{18}, and Na^{24} at E_p = 120 Mev are analogous to the cross sections at E_p = 660 Mev; 120-Mev cross sections being only an order of magnitude lower. The yield ratios for Na^{24} and F^{18} are (Ep = 660 Mev) 1.6 for Sb, 2.2 for Sn, and 2.1 for U. The data on the formation cross sections and angular distributions for Na^{24} from U and Cu at 120 Mev refute the meson mechanism of high momentum transfer to a nucleon group in the nucleus. (R.V.J.)

17150 STUDY OF THE EXCITED LEVELS OF Ir^{188}. Claude Cauquais (Institut du Radium, Orsay, France). J. Phys. Radium, 23: 906-9(Nov. 1962). (In French)

Pt^{188}, produced by spallation of gold, was separated by volatilization of the chlorides in a tube having a strong temperature gradient. The decay of Pt^{188} was investigated with a magnetic β spectrometer working in β−γ coincidence, a γ spectrometer and a slow coincidence circuit. In the study of the decay of Pt^{188}, transitions of 35, 42, 54, 96, 140, 187, 195, 280, 382, and 424 kev were found. The nature and

order of emission of the most important transitions were determined and a level scheme for these transitions is proposed. (auth)

17151 ISOMERIC LEVEL OF Sb^{122}. J. Vanhorenbeeck and L. Binard (CEN, Mol, Belg.). J. Phys. Radium, 23: 951(Nov. 1962). (In French)

The low energy conversion electron spectrum of Sb^{122} was measured using a proportional counter. A 24-kev transition converted into a 3.5-min L shell. It is characterized by $\Delta I = 3$. This places the 3.5-min isomeric level at 159 kev of the Sb^{122} ground level. The period of the 135-kev level was estimated from delayed coincidence measurements to be of the order of 5×10^{-3} sec. (J.S.R.)

17152 PHOTOPROTONS FROM MAGNESIUM. Nobuhiro Yamamuro (Tokyo Inst. of Tech.). J. Phys. Soc. Japan, 18: 11-16(Jan. 1963). (In English)

The energy spectrum and the angular distribution of photoprotons from Mg were measured. The energy spectrum has larger number of fast protons than that expected from the evaporation model and shows the fine structure. The yield of the process leading to the ground state of Na estimated from the experimentally obtained spectrum has some correspondence with that of the inverse proton capture process. The angular distribution of protons of the intermediate energy region in the spectrum has a form $a + b \cdot \sin^2 \theta$ and that of higher energy region shows the possible presence of an interference between electric dipole and electric quadrupole absorptions of photons. (auth)

17153 NUCLEAR ELASTIC SCATTERING OF PHOTONS NEAR THE PARTICLE THRESHOLD ENERGY. [PART] II. Masumi Sugawara, Shigeki Mori, Atsuwo Ono, Akio Hotta, and Motoharu Kimura (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 17-22(Jan. 1963). (In English)

Elastic scattering cross section of photons by a nucleus near the particle threshold energy was studied at 120 degrees for Mg, Fe, Zn, As, Cd, Sb, and Bi using bremsstrahlung gamma rays. Each element has a gross peak in this energy range. This is consistent with the earlier results reported by Tōhei et al. The peak values are 0.5, 1.3, 1.3, 0.6, 1.6, 1.2, and 8 mb, respectively. A systematical relation between the mass number and the energy dependence of the cross section was discussed. (auth)

17154 ANGULAR DISTRIBUTIONS OF (α,n) REACTIONS ON Be AND C. Michiya Kondo, Takashi Yamazaki, and Shotaro Yamabe (Osaka Univ.). J. Phys. Soc. Japan, 18: 22-8(Jan. 1963). (In English)

The angular distributions of neutrons from the $Be^9(\alpha,n)C^{12}$ reaction that leaves C^{12} in its ground-, 4.43- and 9.6-Mev excited states were measured for alpha-particle energies between 17.5 and 22.1 Mev. These angular distributions show patterns that may be interpreted in terms of direct interaction theory. The essential feature of the distributions for each neutron group seems not to change with incident energy. The angular distributions of the ground-state neutron group from the $C^{12}(\alpha,n)O^{15}$ reaction were taken at alpha particle energies from 20.0 to 21.8 Mev. Marked change of distributions with bombarding energies is not found, while it was seen in the $C^{12}(\alpha,p)N^{15}$ reaction at the same energy range. (auth)

17155 PHOTOPROTONS FROM S^{32}. Katsufusa Shoda, Baik Nung Sung, Nobuaki Kawamura, Masayuki Oyamada, Ken Abe, Takeo Ishizuka, and Motoharu Kimura (Tohoku Univ., Sendai). J. Phys. Soc. Japan, 18: 152-3(Jan. 1963). (In English)

The energy spectrum of 24-Mev bremsstrahlung photoprotons from S^{32} was studied using nuclear emulsions. The target thickness was 11.1 mg/cm^2, which determined mainly the resolution of the result (about 2.5% for proton energy of 9 Mev). The cross section of $S^{32}(\gamma,p)P^{31}$ was estimated from experiments on $P^{31}(p,\gamma)S^{32}$. Such comparisons were possible for C^{12}, O^{16}, Ne^{20}, Mg^{24}, Si^{28}, and Ca^{40} for which (p,γ) were previously studied. (C.E.S.)

17156 THE INTERACTION OF RADIATION AND MATTER. A. Scharmann (Universität, Giessen, Ger.). Kerntechnik, 5: 25-8(Jan. 1963). (In German)

Elementary processes in the interaction of radiation with matter are treated, and it is shown that the passage of radiation through matter in general involves the superposition of these processes. Photons, charged particles, and uncharged particles are considered. (D.L.C.)

17157 NEUTRON NUMBERS 98, 108 AND 116. L. H. Ahrens (Massachusetts Inst. of Tech., Cambridge). Nature, 197: 993-4(Mar. 9, 1963).

In a discussion of neutron capture processes and theories of element origin, Malkiél has suggested that the neutron numbers 98, 108, and 116 may be favored. The probability is considered that these neutron numbers are favored, using as evidence a systematic study of the principal isotopes of the elements. An N–Z, Z diagram is presented of the principal isotopes of the stable elements plus those of uranium and thorium. The well-developed discontinuities and displacements at N = 82 and the related discontinuity-developments at N = Z = 20 and N = 50 indicate that the systematics of stable isotopes clearly reflect the effects of the well-known highly favored neutron numbers 20, 50, and 82. Accordingly, if such principal isotope systematics are sensitive in this respect, it is not unreasonable to assume that the discontinuity-displacements at N = 98 and N = 116 indicate that these neutron numbers are also favored, corresponding perhaps to sub-shells or to cluster groups. (C.H.)

17158 $Y^{89}(\gamma,n)Y^{88}$ THRESHOLD AND THE $Zr^{90}-Sr^{88}$ MASS DIFFERENCE. K. N. Geller (Univ. of Pennsylvania, Philadelphia). Nucl. Phys., 40: 177-85(Jan. 1963). (In English)

The $Y^{89}(\gamma,n)$ thresholds to both the ground and first excited state of Y^{88} are observed. The excited state threshold when combined with the known excitation energy of Y^{88} leads to a ground state threshold energy of 11.54 ± 0.04 Mev. This result when coupled with other reaction energies leads to a value of 1.999682 amu for the $Zr^{90}-Sr^{88}$ mass difference. This value disagrees with the mass spectroscopic determination of the $Zr^{90}-Sr^{88}$ mass difference by 200 μmu. A value is also given for the $Zr^{90}(\gamma,n)Zr^{89}$ threshold (11.94 ± 0.05 Mev). (auth)

17159 SMALL ANGLE ELASTIC SCATTERING OF NEUTRONS BY URANIUM AT ENERGIES BETWEEN 18 Mev AND 120 Mev. P. H. Bowen (Atomic Energy Research Establishment, Harwell, Berks, Eng.), G. C. Cox, G. B. Huxtable, J. P. Scanlon, J. J. Thresher, A. Langsford, and H. Appel. Nucl. Phys., 40: 186-94(Jan. 1963). (In English)

Measurements are made of the differential scattering cross sections and polarizations for the elastic scattering of neutrons by uranium at angles of 1, 2½, and 4½°, in the energy range 18 to 120 Mev. The cross section data are analyzed to yield information on the forward scattering amplitude, which is found to be dominated by its imaginary part throughout the energy range. Nuclear polarizations at these angles and energies are very small. (auth)

17160 THE INFLUENCE OF THE CONFIGURATIONS WITH TWO OR MORE PARTICLE-HOLE PAIRS ON THE

STRUCTURE OF THE GIANT RESONANCE. M. V. Mihailović and M. Rosina (Nuclear Institut "J. Stefan", Ljubljana, Yugoslavia). Nucl. Phys., 40: 252-9(Jan. 1963). (In English)

The dipole giant resonance is studied in nuclei with unfilled shells. It is shown that, in comparison with closed-shell nuclei, there exists an additional effect that seriously influences the form of the giant resonance. This effect consists in two or more particle-hole pairs being excited indirectly by means of the residual forces between these configurations and the dipole ones. It is shown that the most effective are those two-pair configurations, which correspond to the excitation in which one nucleon is lifted into the neighboring shell whereas the other is only displaced in the same shell. The inclusion of these configurations generates a number of states, each of which takes away some dipole strength from the calculated dipole states. The number of these states, their energies, and strength distribution as influenced by this effect are calculated for C^{12}. A relation is derived between the width of the giant resonance and the number of valence nucleons. The influence of the one-quantum-two-pair configurations on the form of the giant resonance is calculated approximately for Ne^{20}. (auth)

17161 SOME FEATURES OF THE INTERACTIONS OF 24 Gev PROTONS WITH HEAVY NUCLEI IN EMULSION. J. Bogdanowicz, P. Ciok, Z. Galster, T. Saniewska, and P. Zieliński (Univ. of Warsaw and Inst. of Nuclear Research, Warsaw). Nucl. Phys., 40: 270-81(Jan. 1963). (In English)

A sample of 121 interactions of 24 Bev protons with heavy nuclei in emulsion ($N_h > 8$) were investigated. The general characteristics of stars and angular distributions of black, grey, and lightly ionizing tracks were analyzed. (auth)

17162 THE CORRELATION BETWEEN SPECTRA AND THE NUMBER OF NEUTRONS EVAPORATED FROM AN EXCITED NUCLEUS. I. Nebenzahl and G. Rakavy (Hebrew Univ., Jerusalem). Nucl. Phys., 40: 293-5(Jan. 1963). (In English)

Simple analytical expressions are obtained for the spectra of neutrons evaporated from an excited nucleus when the number of simultaneously emitted particles is given. (auth)

17163 PION PHOTOPRODUCTION UP TO MEDIUM ENERGIES. E. W. Hendry (Univ. of Glasgow). Nucl. Phys., 40: 296-308(Jan. 1963). (In English)

Pion photoproduction is studied using the N/D method with pole approximations for the left-hand cuts. The cross sections arising from the $J = 3/2$ magnetic and electric dipoles are calculated, and resonances obtained corresponding to the first two photoproduction resonances. The results are strongly dependent on pion-nucleon scattering; various other features are discussed. (auth)

17164 PERTURBATION THEORY IN NUCLEAR MATTER WITH REGULAR BUT VELOCITY DEPENDENT INTERACTIONS. J. Da Providencia (Universidade, Coimbra, Portugal). Nucl. Phys., 40: 321-8(Jan. 1963). (In English)

Considering regular but velocity-dependent interactions, the direct and exchange terms of the second-order energy for nuclear matter are calculated. A study is made of whether such interactions, which can be fitted to the two-body data, lead to a quickly converging perturbation series. A rather large contribution from singlet-even states to the direct and exchange term, at densities corresponding to $k_F = 1.5\ fm^{-1}$, indicates a very slow convergence even in the absence of a hard-core interaction. This result is partially caused by the short range of the velocity-dependent term in the interaction. (auth)

17165 PRECISION DETERMINATION OF GAMMA ENERGIES OF NUCLEI WITH A = 152-197. Ingvar Marklund and Boerje Lindstroem (Univ. of Uppsala). Nucl. Phys., 40: 329-37(Jan. 1963). (In English)

A curved-crystal spectrometer was used for precision measurements of gamma energies against the $K\alpha_1$ line of tungsten. The energies of one or several gamma rays were determined from $Eu^{152\,m}$, Dy^{165}, Ho^{166}, Tm^{170}, Lu^{177}, W^{187}, Re^{186}, Re^{188}, Ir^{192}, Ir^{194}, and Hg^{197}. (auth)

17166 SHELL MODEL INVESTIGATION OF RaE BETA-DECAY. Richard M. Spector (Centre d'Etudes Nucleaires, Saclay, France). Nucl. Phys., 40: 338-46(Jan. 1963). (In English)

Starting from the assumption of accidental cancellation of matrix elements, the shape correction factor and the electron polarization for RaE beta decay are investigated. The phenomenologically acceptable range of the two relevant parameters is determined. The first of these, designated A, is investigated theoretically by calculating the necessary shell-model matrix elements using both zero-order and then first-order wave functions for RaE. The results obtained for A with first-order wave functions, which arise from the breaking up of the rigid core of RaE, are seen to resolve the disagreement between theory and experiment. The same first-order wave functions are also used to calculate the magnetic moment of RaE, and agreement with the experimental value is obtained. (auth)

17167 ANGULAR DISTRIBUTION OF POLARIZED NEUTRONS FROM THE $Li^7(p,n)Be^7$ REACTION. I. Mînzatu, N. Martalogu, A. Calboreanu, I. Vîlcov, and T. Magda (Inst. of Atomic Physics, Bucharest). Nucl. Phys., 40: 347-52(Jan. 1963). (In English)

The angular distribution of the polarization of neutrons from the $Li^7(p,n)Be^7$ reaction is studied in an angular interval ranging from 5 to 70°, in 5° steps. The incident proton energy is about 4.3 Mev. The measurements are carried out by a time-of-flight method. The experimental data show that the polarization is positive in this angular interval with a peak in the vicinity of 40°. (auth)

17168 EFFECTS OF KNOCK-OUT MODE IN (d,p) AND (d,n) REACTIONS. Makoto Tanifuji (Hosei Univ., Tokyo). Nucl. Phys., 40: 357-86(Jan. 1963). (In English)

A formulation of the knock-out mode in (d,p) or (d,n) reactions is attempted with the cut-off Born approximation and the j-j coupling scheme for the initial and final nuclei. During the collision between an incident deuteron and the target proton (or neutron), the proton-proton (or neutron-neutron) interaction as well as the neutron-proton interaction are actually taken into consideration. The theoretical analyses are carried out on the reactions of $N^{14}(d,p)N^{15}$(g.s.), $C^{12}(d,p)C^{13}$(g.s.) and $Be^9(d,p)Be^{10}$(g.s.) at several incident energies, with the assumption that the reactions take place only through the stripping and knock-out modes. Some systematic deviations of the experimental cross sections from the simple Butler theory, observed in the range of E_d = 3 to 15 Mev, can be explained satisfactorily through allowing for knock-out effects. Under the same assumption, the $O^{16}(d,n)F^{17}$(g.s.) reaction together with the $O^{16}(d,p)O^{17}$(g.s.) reaction are studied for several deuteron energies with satisfactory results. The $Mg^{24}(d,p)Mg^{25}$(g.s.)

reaction is also similarly analyzed. The anomaly of the angular distribution observed at E_d = 14.8 Mev in this reaction is discussed. The angular distributions of the $B^{10}(d,p)B^{11*}$(2.14 Mev) reaction in the range E_d = 8.1 to 10.0 Mev are calculated as a pure knockout mode and the results are compared with those of experiment and previous theories. The result of this analysis is found to favor the present theory. (auth)

17169 GAMMA-GAMMA DIRECTIONAL CORRELATIONS IN Rh^{105}. Atam P. Arya (Pennsylvania State Univ., University Park). Nucl. Phys., 40: 387-95(Jan. 1963). (In English)

Directional correlation measurements are made on the 320–475 kev and 485–475 kev gamma-gamma cascades in Rh^{105} following the decay of 4.5-hr half-life Ru^{105} with a coincidence scintillation spectrometer using NaI detectors. The observed correlation functions are determined for the two cascades. These gamma-gamma directional correlations are found to be consistent with the spin assignment of $^7/_2$, $^7/_2$, $^5/_2$, and $^7/_2$ to the levels at the ground state, 475, 795, and 960 kev in Rh^{105}. The probable assignment of multipolarities for different gamma rays is as follows: the 475-kev gamma ray has a mixture of (30 to 55)% dipole and (45 to 70)% quadrupole; the 485-kev gamma ray has a mixture of (0 to 20)% dipole and (80 to 100)% quadrupole; and the 320-kev gamma ray has a mixture of (95 to 96.5)% dipole and (3.5 to 5)% quadrupole. (auth)

17170 INTERNAL CONVERSION OF THE 1277 kev TRANSITION IN ^{22}Ne. Yasuyuki Nakayama and Haruyoshi Hirata (Kyoto Univ.). Nucl. Phys., 40: 396-9(Jan. 1963). (In English)

The internal conversion coefficient of the 1277-kev transition in Ne^{22} is measured using an intermediate-image beta spectrometer. The measured value of α_t = $(6.77 \pm 0.45) \times 10^{-6}$ is in agreement with the theoretical value for a pure E2 transition corrected for the screening effect. (auth)

17171 ANGULAR DISTRIBUTIONS IN $O^{16}(d,\alpha)N^{14}$ AND $C^{12}(d,\alpha)B^{10}$ REACTIONS. J. Jastrzebski (Inst. of Nuclear Research, Warsaw), F. Picard, J. P. Schapira, and J. L. Picou. Nucl. Phys., 40: 400-11(Jan. 1963). (In French)

Angular distributions of alpha particles from the reactions $O^{16}(d,\alpha)N^{14}$ and $C^{12}(d,\alpha)B^{10}$ were studied by means of solid state detectors. The alpha group leading to the T = 1 level of N^{14}, forbidden by isobaric spin selection rule, was observed. The forward peaked angular distribution could be the result of interference between direct interaction and compound nucleus formation. (auth)

17172 MAGNETIC DIPOLE TRANSITIONS IN EVEN NUCLEI AND PURITY OF SEPARATION OF COLLECTIVE QUADRUPOLE DEGREES OF FREEDOM. D. P. Grechukhin (Kurchatov Inst. of Atomic Energy, Moscow). Nucl. Phys., 40: 422-37(Jan. 1963). (In English)

Magnetic transitions of even nuclei with collective quadrupole-type excitations are considered in detail. It is shown that δ^2(E2/M1), the ratio of probabilities for the interfering E2 and M1 nuclear radiations in the mixed transition of the nucleus $I_i(M1 + E2)I_f$, does not depend on the specific structure of the model Hamiltonian of nuclear collective motion, but is rather sensitive to the admixture of single-particle excitations in the collective states of the nucleus. Thus, the experimental deviation of δ^2_{exp}(E2/M1) from the quantity δ^2_{coll} predicted by collective models may serve as measure of the purity of separation of the nuclear collective degrees of freedom. Practically all known quantities δ^2_{exp} are compared with the theoretical values of δ^2_{coll} for nuclei in the interval $56 \leqq A \leqq 232$. (auth)

17173 THE 355 AND 439 kev RESONANCES IN THE REACTION $^{31}P(p,\gamma)^{32}S$. L. K. Ter Veld and H. Brinkman (Rijksuniversiteit, Groningen, Netherlands). Nucl. Phys., 40: 438-42(Jan. 1963). (In English)

The 355- and 439-kev (p,γ) resonances on phosphorus were investigated. The decay schemes and the relative intensities of the electromagnetic transitions were determined. No ground-state transition from the 4.47-Mev level was observed. From the thick target yield the resonance strengths could be calculated. Angular distribution measurements permitted the assignment of a spin 1 to both resonance levels. (auth)

17174 MECHANISM OF THE $C^{12}(p,p'3\alpha)$ REACTION FOR PROTON ENERGIES OF 15 TO 29 Mev. S. S. Vasilyev, V. V. Komarov, and A. M. Popova (Moscow State Univ.). Nucl. Phys., 40: 443-56(Jan. 1963). (In English)

The $C^{12}(p,p'3\alpha)$ reaction is investigated for proton energies of 15 to 29 Mev. The reaction is studied by five-pronged stars produced in photoplates irradiated in a synchrotron. Energy distributions of the decay products and excitation energies of possible intermediate nuclei C^{12}, B^9 and Be^8 are given. The experimental data warrant the conclusion that the principal mechanism for the reaction under investigation is the decay of the system N^{13} into three α-particles and the proton with resonance interaction of the products at the levels of Be^8 and Li^5. (auth)

17175 BINDING ENERGIES OF THE Λ^0-HYPERON IN HYPERNUCLEI. B. Bhowmik, D. P. Goyal, and N. K. Yamdagni (Univ. of Delhi). Nucl. Phys., 40: 457-62(Jan. 1963). (In English)

An analysis of 29 hypernuclei, produced by the interactions of K^- mesons and Σ^- hyperons in nuclear emulsion and decaying in the π^--mesic mode, is presented. Binding energies of the Λ^0 hyperon in the hypernuclei $_\Lambda H^4$(6 events), $_\Lambda He^4$(4 events), $_\Lambda He^5$(9 events) and $_\Lambda Li^8$(1 event) are obtained as (2.37 ± 0.30) Mev, (2.27 ± 0.27) Mev, (3.27 ± 0.18) Mev, and (7.75 ± 0.80) Mev, respectively. The binding energies are derived from the Q_Λ-value determined in the same emulsion stack from which the hyperfragment data originate. This makes the systematic errors in the binding energies negligible; the errors quoted are therefore only statistical. Besides the most commonly occurring decay mode of $_\Lambda He^5$, the rare decay mode $_\Lambda He^5 \rightarrow He^3 + He^2 + \pi^-$ is also observed. (auth)

17176 THE DENSITY DISTRIBUTION OF He^6. A. R. Bodmer and Saqeba S. Ali (Univ. of Manchester, Eng.). Nucl. Phys., 40: 463-71(Jan. 1963).

A two-parameter density distribution was obtained for He^6 using an oscillator shell model distribution with different oscillator length parameters α_s and α_p for the s and p-nucleons respectively. One relation between α_s and α_p is obtained by equating the calculated Coulomb energy difference between He^6 and the lowest T = 1 state of Li^6 with the empirical value while a second relation is obtained using a method that gives agreement for the form factor of Li^6, and assumes that the s-nucleon distribution is a recoiling-α-particle effect. One then obtains α_s = 1.79 ± 0.04 fm, α_p = 2.60 ± 0.06 fm and $\langle r^2 \rangle^{\frac{1}{2}}$ = 2.78 ± 0.05 fm for the r.m.s. radius of the point nucleon distribution. Compared with Li^6 the extension of the s-nucleons is only slightly greater. However, $\langle r^2 \rangle^{\frac{1}{2}}$ and the extension of the p-nucleons is significantly greater, consistent with the smaller binding energy of the p-nucleons in He^6. The effect

of the Coulomb interaction in extending the p-nucleons in the T = 1 state of Li^6 beyond those in He^6 is shown to be negligible. (auth)

17177 BETA DECAY THEORY USING EXACT ELECTRON RADIAL WAVE FUNCTIONS. Wolfgang Buehring (Universität, Heidelberg). Nucl. Phys., 40: 472-88(Jan. 1963). (In English)

A modified formulation of the theory of beta decay is presented, in which exact electron radial wave functions for an extended nuclear charge distribution are used. The resulting formulas are suitable for accurate application as well as for a qualitative demonstration of the features of beta decay. The connection between spectrum shape and electron polarization can be seen directly. Some of the difficulties in the treatment of the pseudo-scalar coupling disappear. (auth)

17178 HALF-LIVES OF TWO EXCITED STATES IN Yb^{172}. B. Herskind and D. B. Fossan (Universitet, Copenhagen). Nucl. Phys., 40: 489-94(Jan. 1963). (In English)

The half lives of the 1174.0- and 78.7-kev excited states in Yb^{172} are measured by the fast time-to-height conversion technique. The half life of the 1174.0-kev 3^+, K = 3 state is $(8.7 \pm 0.4) \times 10^{-9}$ sec, implying hindrances of $\approx 10^3$ for the two E2, singly K-forbidden transitions to the ground-state rotational band. The half life of the 78.7 kev 2^+ first excited state is $(1.5 \pm 0.1) \times 10^{-9}$ sec. An experimental $2^+ \rightarrow 0^+$ total internal-conversion coefficient is determined from this lifetime measurement and the B(E2) value, which is larger than the theoretical conversion coefficient by $(14 \pm 10)\%$. (auth)

17179 INTERACTIONS OF PHOTONS AND ELECTRONS AT HIGH ENERGIES IN CRYSTALS. G. Diambrini-Palazzi (Comitato Nazionale per l'Energia Nucleare, Rome). Nuovo Cimento (10), 25: Suppl. No. 2, 88-99(1962). (In Italian)

A review is presented on the principal theoretical and experimental results on the mechanisms for the production of pairs and bremsstrahlung at high energy in periodic crystalline structures. The effects which these results can have on experimentation with high energy electron accelerators are indicated. (J.S.R.)

17180 FISSION OF URANIUM, THORIUM AND BISMUTH BY 20 Gev PROTONS. H. G. de Carvalho (Istituto Nazionale di Fisica Nucleare, Naples and Università, Naples), G. Cortini, M. Muchnik, G. Potenza, R. Rinzivillo, and W. O. Lock. Nuovo Cimento (10), 27: 468-74(Jan. 16, 1963). (In English)

The cross sections for the proton induced fission of U, Th, and Bi were measured at 20 and 21.8 Bev. They turn out to be smaller than at 600 Mev by a factor between 3 and 4, while the ratios of the cross sections of the various elements remain approximately constant in the same energy interval. (auth)

17181 SOFT GAMMA-RAYS FROM THERMAL NEUTRON CAPTURE IN Ho, Tm, Lu–I. M. Giannini, D. Prosperi, and S. Sciuti (Centro di Studi Nucleari della Casaccia, Rome and Università, Rome). Nuovo Cimento (10), 27: 538-42(Jan. 16, 1963). (In English)

Low energy neutron capture γ rays were used to investigate the odd-odd nuclei Ho^{166}, Tm^{170}, and Lu^{176}. The samples were in the form of powdered oxides pressed into aluminum containers. They were bombarded by a neutron beam with thermal flux 4×10^{12} n cm^{-2} s^{-1} at 100 kw thermal power. The absolute intensities of the γ rays were calculated in the conventional way. (C.E.S.)

17182 ON THE EFFECT OF PAIRING CORRELATIONS ON β-DECAYS NEAR CLOSED SHELLS. L. Silverberg and A. Winther (Univ. of Minnesota, Minneapolis and Univ. of Copenhagen). Phys. Letters, 3: 158-9(Jan. 1, 1963). (In English)

Nuclear wave functions, obtained by the introduction of a pairing force into the description of low-energy nuclear properties, are applied to the calculation of transition rates in nuclear beta decay. Only allowed and some first-forbidden transitions are considered of nuclear near closed shells. The calculated and experimental log ft values are compared. (T.F.H.)

17183 SLOW NEUTRON SCATTERING EVIDENCE FOR VIOLATING OF THE f-SUM RULE IN LIQUID SODIUM. P. D. Randolph (Phillips Petroleum Co., Idaho Falls, Idaho). Phys. Letters, 3: 162-5(Jan. 1, 1963). (In English)

The partial differential cross sections for the scattering of 25-, 70-, and 100-mev neutrons by liquid Na at 100, 150, and 200°C are measured. The zeroth and first moments of the energy transfer are determined. It is found that the zeroth moment agrees with theory, but that the first moment is larger by a factor of ~3 than the theoretical prediction. This discrepancy implies that the translation recoil kinetic energy of the scattering particle does not account for all of the energy exchanged in the collision. (T.F.H.)

17184 ON THE POSSIBILITY OF MEASURING THE η_0 LIFETIME BY DETECTING THE "PRIMAKOFF EFFECT." G. Bellettini (Università Pisa, Italy and Istituto Nazionale di Fisica Nucleare, Pisa, Italy), C. Bemporad, P. L. Braccini, L. Foà, and M. Toller. Phys. Letters, 3: 170-1(Jan. 1, 1963). (In English)

The production of the η^0 meson by the reaction $\gamma + \gamma \rightarrow \eta^0$ is considered, where one of the γ's is furnished by a nuclear coulomb field. The cross section is proportional to the $\eta^0 \rightarrow 2\gamma$ decay width, so that the cross section can be used to determine the η^0 lifetime. The necessity of using incident photons of 1 Bev energy or greater is noted. (T.F.H.)

17185 EXPERIMENTAL EVIDENCE FOR THE DISSOCIATION OF DEUTERONS DURING COLLISIONS WITH NUCLEI. F. Udo and L. A. Ch. Koerts (Instituut voor Kernphysisch Onderzoek, Amsterdam). Phys. Letters, 3: 181-3(Jan. 1, 1963). (In English)

Reactions (d,np) on Au and Cu are analyzed at deuteron energies of 23 and 26 Mev, in order to determine the mechanisms for the deuteron breakup. Differential cross sections and spectra are measured and analyzed. (T.F.H.)

17186 SECOND BORN APPROXIMATION FOR ELECTRON AND POSITRON SCATTERING BY NUCLEI. G. Bisiacchi and G. Furlan (Università Trieste, Italy and Istituto Nazionale di Fisica Nucleare, Trieste, Italy). Phys. Letters, 3: 186-8(Jan. 1, 1963). (In English)

The second Born approximation is evaluated for the elastic scattering of a point fermion by the Coulomb field of a fixed nucleus. Experimental results are compared with this approximation for the cases of electron (+ or –) scattering by (electron incident energies in parentheses, in Mev): C^{12}(420); C^{12}(800); Co^{59}(183); Co^{59}(300); and H^2(1000). (T.F.H.)

17187 HYPERFINE INTERACTIONS IN THE GROUND STATE AND FIRST EXCITED STATE OF Tm^{169} IN THULIUM IRON GARNET. I. Nowik and S. Ofer (Hebrew Univ., Jerusalem). Phys. Letters, 3: 192-4(Jan. 1, 1963). (In English)

The hyperfine splitting of the 8.6-kev gamma ray from

Tm^{169m} in thulium iron garnet at 90, 100, and 300°K is measured. Values for the effective magnetic field at the Tm nucleus, and for the magnetic moment of the 8.6-kev state, are calculated. The splitting is measured by means of the Mössbauer effect, using a source of Er_2O_3 at 450°C. The ratio of the magnetizations of the Tm sublattice in the garnet at 300 and 90°K is measured. (T.F.H.)

17188 RESONANT BEHAVIOUR IN LARGE-ANGLE (p,α) AND (α,p) DATA. H. R. Blieden (Universitet, Copenhagen). Phys. Letters, 3: 257-60(Feb. 1, 1963). (In English)

Evidence that interfering levels in the compound system produce the backward peaks observed in angular distributions for bombarding energies less than 35 Mev is examined. Direct reaction and resonant contributions to peaks in the reactions $F^{19}(p,\alpha)O^{16}$ and $C^{12}(\alpha,p)N^{15}$ are calculated and compared; resonant levels seem to explain the peaks. Peaks in the reactions $O^{16}(\alpha,\alpha)O^{16}$, $C^{12}(\alpha,\alpha)C^{12}$, and $C^{13}(He^3,\alpha)C^{12}$ are also discussed. (D.C.W.)

17189 THE (p,n) REACTIONS AND BETA DECAYS. K. Ikeda, S. Fujii, and J. I. Funjita (Nihon Univ., Tokyo). Phys. Letters, 3: 271-2(Feb. 1, 1963). (In English)

A simplified model is used to study the correlation effect among (n,p) pairs with $I^\pi = 1^+$. Empirical data on allowed beta transitions are examined using the model. (D.C.W.)

17190 AN EXAMPLE OF THE π^+ DECAY OF A HELIUM HYPERNUCLEUS. P. Allen, M. Heeran, and A. Montwill (University Coll., Dublin). Phys. Letters, 3: 274-5 (Feb. 1, 1963). (In English)

An event interpreted as the π^+ decay of a He^4 hypernucleus was observed in the 1.3 Bev/c K^- stack exposed at CERN. Investigation of possible decay schemes points to the process $He^4 \rightarrow \pi^+ + H^3 + n$, and an unusually high π^+ energy is noted. (D.C.W.)

17191 PRODUCTION OF HYPERFRAGMENTS FROM THE INTERACTIONS OF 1.3 Gev/c AND 1.5 Gev/c K^- MESONS WITH EMULSION NUCLEI. E. R. Fletcher (Univ. of Bristol, Eng., J. Lemonne, P. Renard et al. Phys. Letters, 3: 280-3(Feb. 1, 1963). (In English)

Study of particle interactions in emulsion stacks exposed to 1.3 and 1.5 Bev/c K^- meson beams gives support to the idea that hyperfragments of range less than 10 μm are residual spallation products containing trapped Λ^0 hyperons resulting from K^- interactions in emulsion nuclei. (D.C.W.)

17192 γ-QUANTA PRODUCTION IN THE INTERACTION OF 7 Gev π^--MESONS WITH NUCLEI. V. B. Lyubimov, Mu Jun, M. I. Podgoretskii, S. I. Portnova, V. N. Streltsov, and Z. Trka (Joint Inst. for Nuclear Research, Dubna, USSR). Phys. Letters, 3: 287-9(Feb. 1, 1963). (In English)

Other means of γ production than π^0 decay in inelastic interactions of π^- mesons with nucleons are indicated by observed maxima at 250-300 Mev and 500-800 Mev. Decay of the η meson into two γ quanta seems likely. (D.C.W.)

17193 TRANSITION PROBABILITIES OF THE FIRST EXCITED STATES IN THE NUCLEI: Au^{193}, Au^{195} AND Au^{197}. J. Jastrzebski (Inst. of Nuclear Research, Warsaw). Phys. Letters, 3: 289-91(Feb. 1, 1963). (In French)

The probabilities for some transitions in the first excited states of Au^{193}, Au^{195}, and Au^{197} nuclei are given and discussed in terms of Nilsson and Shalit nuclear models. (D.C.W.)

17194 THE g-FACTOR OF THE 2.083 Mev 4^+ STATE OF THE Ce^{140}. N. Kaplan, S. Ofer, and B. Rosner (Hebrew Univ., Jerusalem). Phys. Letters, 3: 291-3(Feb. 1, 1963). (In English)

The gyromagnetic ratio of the 2.083-Mev level of Ce^{140} is determined to be about 1.15 ± 0.08 by a method that avoids corrections for the presence of background coincidence. An assignment of $(d_{\frac{5}{2}}, g_{\frac{7}{2}})$ is indicated for the state. Both quantities differ from other results. (D.C.W.)

17195 CLUSTER MODEL IN $Ne^{20}(\alpha,C^{12})C^{12}$ REACTION. H. Horie (Tokyo Inst. of Tech.) and M. Tanifuji. Phys. Letters, 3: 294-6(Feb. 1, 1963). (In English)

Angular distributions for the reaction $Ne^{20}(\alpha,C^{12})C^{12}$ for incident energies of 15-20 Mev are calculated using the Butler theory with a cluster model for the nucleus. The observed distributions can be accounted for by stripping and pick-up processes. (D.C.W.)

17196 COINCIDENCE STUDY OF THE $K^{39}(n,p\gamma)A^{39}$ AND $K^{39}(n,\alpha\gamma)Cl^{36}$ REACTIONS. R. Bass and F. M. Saleh (Johann Wolfgang Goethe Universität, Frankfurt am Main). Phys. Letters, 3: 296-9(Feb. 1, 1963). (In English)

The reactions $K^{39}(n,p\gamma)Ar^{39}$ and $K^{39}(n,\alpha\gamma)Cl^{36}$ have been investigated using a KI(Tl) charged particle detector and a NaI(Tl) γ detector. Evidence for a cascade transition from the 2.10-Mev level in Ar^{39} via the 1.27-Mev level was noted, and new levels at 2.36, 2.66, and 2.76 Mev were found. Spectra and level diagrams are included. (D.C.W.)

17197 OBSERVATION OF ALPHA PARTICLES ARISING FROM THE REACTION $Li^6 + Li^7$. A. Garin, C. Lemeille, L. Marquez, and N. Saunier (Centre d'Etudes Nucléaires, Saclay, France). Phys. Letters, 3: 299-300 (Feb. 1, 1963). (In French)

Continuous spectra for charged particles emitted in the reaction $Li^6 + Li^7$ were obtained by two methods with good agreement. The origin of the spectra is examined. (D.C.W.)

17198 POLARISATION IN PROTON–CARBON SCATTERING AT 28 Mev. R. M. Craig (Univ. of Birmingham, Eng.), J. C. Dore, G. W. Greenlees, J. S. Lilley, and P. C. Rowe. Phys. Letters, 3: 301-2(Feb. 1, 1963). (In English)

Elastic and inelastic scattering polarization of 28-Mev protons on carbon is examined, and an attempt is made to fit the elastic polarization and differential cross section data using an optical model potential. (D.C.W.)

17199 CONCERNING THE MAGNETIC PROPERTIES OF DEFORMED NUCLEI IN THE REGION $153 \leq A \leq 187$. J. De Boer (California Inst. of Tech., Pasadena) and John D. Rogers. Phys. Letters, 3: 304-6(Feb. 1, 1963). (In English)

Previous calculations of the parameters g_R and g_K that describe the magnetic properties of a deformed nucleus disagreed with theoretical predictions of Nilsson's model. New calculations have been made for fifteen deformed odd-A nuclei using the latest experimental results. (D.C.W.)

17200 ON THE 992 kev $Al^{27}(p,\gamma)Si^{28}$ RESONANCE. L. Simons, K. E. Nysten, M. Koskelin, O. Siltanen, E. Spring, and G. Wendt (Univ. of Helsinki). Phys. Letters, 3: 306-8(Feb. 1, 1963). (In English)

Gamma and coincidence spectra originating from the 992-kev resonance in the $Al^{27}(p,\gamma)Si^{28}$ reaction were measured to establish a decay scheme and spin assignment for the resonance level. An assignment of 3^+ is made. (D.C.W.)

17201 NOTE ON THE 1^- STATE IN THE VIBRATIONAL REGION. M. Sakai (Tokyo Univ.). Phys. Letters, 3: 338-9 (Feb. 15, 1963). (In English)

A compilation of experimental de-excitation characters of the 1^- state in the vibrational region just outside the neutron number 90 is given to compare its de-excitation characters

with those in the rotational region. Various explanations for this state are given. (C.E.S.)

17202 LIFETIME OF THE HELIUM HYPERNUCLEI. R. G. Ammar, W. Dunn, and M. Holland (Northwestern Univ., Evanston, Ill.). Phys. Letters, 3: 340-2(Feb. 15, 1963). (In English)

Information on the lifetimes of charge 2 hypernuclei and, in particular, the lifetime of $_{\Lambda}He^{5}$ is presented. The events under consideration were all produced by K^{-} capture in nuclear emulsion. The scanning was restricted to detecting only those hypernuclei that were produced and decayed in the same pellicle. The lifetime of $_{\Lambda}He^{5}$ was found to be $\geq 0.9 \times 10^{-10}$ sec. (C.E.S.)

17203 THE ANGULAR DISTRIBUTION OF γ-RAYS FROM THE FISSION OF U^{235}. S. Dési, G. Graff, A. Lajtai, and L. Nagy (Central Research Inst. of Physics, Budapest). Phys. Letters, 3: 343-4(Feb. 15, 1963). (In English)

Experimental investigations covering the angular distribution of γ rays emitted in the slow neutron induced fission of U^{235} are reported. Uranium enriched to 96% in U^{235}, deposited electrolytically on 1 mm aluminum backing, was used as a target. (C.E.S.)

17204 THE SYMMETRY TERM IN THE NUCLEAR OPTICAL POTENTIAL. P. E. Hodgson (Nuclear Physics Lab., Oxford). Phys. Letters, 3: 352-4(Feb. 15, 1963). (In English)

Compilations of optical potentials obtained from analyses of nucleon elastic scattering data are given to present empirical evidence for the symmetry term in the neutron optical potential. The parameters fluctuate markedly as a function of energy and from one nucleus to another. These fluctuations are due partly to inherent ambiguities of the model and the uncertainties in the measured cross sections. The resulting values of the strength of the imaginary potential for neutron scattering do not show any systematic variation with the symmetrical parameter but the possibility of such an effect cannot be excluded. (C.E.S.)

17205 STATISTICAL AVERAGING OF $(p,p'\gamma)$ ANGULAR DISTRIBUTIONS TO OBTAIN E2/M1 MIXING RATIOS FOR $2^{+\prime}(M1,E2)2^{+}$ γ-TRANSITIONS IN EVEN NUCLEI. A. K. Sen Gupta and D. M. Van Patter (Bartol Research Foundation, Swarthmore, Penna.). Phys. Letters, 3: 355-7 (Feb. 15, 1963). (In English)

Under appropriate conditions, measurements of the angular distributions of the deexcitation γ rays from the second 2^{+} state provide information on δ, the E2/M1 mixing ratio. This method offers distinct advantages in that it does not involve coincidence measurements and it can be applied readily to many even nuclei that may be inaccessible for radioactivity studies. Results on the measurements of δ for the $2^{+\prime} \rightarrow 2^{+}$ transitions in Ni^{60}, Zn^{64}, and Zn^{66} are presented. (C.E.S.)

17206 STATISTICAL MODEL CALCULATIONS OF (n,α) CROSS SECTIONS INDUCED BY 14 Mev NEUTRONS. U. Facchini, E. Saetta-Menichella, F. Tonolini, and L. Tonolini (CISE, Milan). Phys. Letters, 3: 361-4 (Feb. 15, 1963). (In English)

The values of (n,α) cross sections at 14 Mev, obtained from statistical model computations, are compared with a series of recent experimental measurements. (C.E.S.)

17207 GAMMA-RAY SPECTRUM FROM THE RADIATIVE CAPTURE OF 14 Mev NEUTRONS IN Al^{27}. F. Cvelbar, A. Hudoklin, M. V. Mihailović, M. Najžer, and V. Ramšak (Nuclear Institute "Jozef Stefan", Ljubljana, Yugoslavia). Phys. Letters, 3: 364-6(Feb. 15, 1963). (In English)

A method for the measurement of the γ energy spectrum from 14-Mev neutron capture is described, and the results for Al^{27} are presented. (C.E.S.)

17208 MEASUREMENT OF THE TRANSVERSE DOPPLER EFFECT IN AN ACCELERATED SYSTEM. Walter Kuendig (Purdue Univ., Lafayette, Ind.). Phys. Rev., 129: 2371-5(Mar. 15, 1963). (TID-17267)

Using an ultracentrifuge rotor, the shift of the 14.4-kev Mössbauer absorption line of Fe^{57} in a rotating system was measured as a function of the angular velocity ω. An Fe^{57} absorber was placed at a radius of 9.3 cm from the axis of the rotor. A Co^{57} source was mounted on a piezoelectric transducer at the center of the rotor. By applying a triangularly varying voltage to the transducer, the source could be moved relative to the absorber. This arrangement made possible the observation of the entire resonance line at various values of ω. The measured transverse Doppler shift agreed within an experimental error of 1.1% with the predictions of the theory of relativity. Possible sources of systematic errors were discussed. (auth)

17209 LINEAR STARK SPLITTING OF NUCLEAR SPIN LEVELS IN GaAs. D. Gill and N. Bloembergen (Harvard Univ., Cambridge, Mass.). Phys. Rev., 129: 2398-2403(Mar. 15, 1963).

A quadrupole splitting of the fourfold-degenerate nuclear spin levels of Ga^{69}, Ga^{71}, and As^{75} in a single crystal of GaAs is induced by the application of a d-c electric field along the [111] direction. The splitting of the nuclear magnetic resonance is observed and the coupling constants R_{14} between the induced gradient tensor and the applied homogeneous electric field are determined. The results are $R_{14}(Ga^{69}) = 1.05 \times 10^{10}$ cm^{-1}, $R_{14}(Ga^{71}) = 0.9 \times 10^{10}$ cm^{-1}, and $R_{14}(As^{75}) = 1.55 \times 10^{10}$ cm^{-1}. A simple theoretical model explains the physical origin of this effect. (auth)

17210 SPIN HAMILTONIAN PARAMETER D VERSUS AXIAL CRYSTAL FIELD FOR S-STATE IONS. W. J. Nicholson (Columbia Univ., New York) and Gerald Burns. Phys. Rev., 129: 2490-5(Mar. 15, 1963).

Measurements are made, in a Mössbauer absorption experiment, of the nuclear quadrupole splitting of the $^{6}S_{\frac{5}{2}}$ state ion Fe^{3+} substituted in several compounds. The compounds chosen are those for which the quantity D in the electron spin resonance Hamiltonian is known. The measured quadrupole coupling eqQ/h is directly proportional to the axial crystal field, V_{ax}. Hence, it is possible to compare the results of the dependence of D on the axial crystal field with theoretical predictions. It is found that considerable scatter of data points occurs. This scatter is possibly the result of covalent bonding or the distortion of the iron wave functions by the surrounding ions. Moreover, a functional dependence of any smooth curve through the experimental points disagrees with the theoretical calculations. If the data are to be crudely fit by a smooth curve, the sign of the coefficient of V_{ax}^{2} should be positive and not negative as theory indicates. Finally, there is serious disagreement between theory and experiment on the dependence of the D vs V_{ax} curve on the particular paramagnetic ion (i.e., on whether the substituted ion is Fe^{3+} or Mn^{2+}). (auth)

17211 DETERMINATION OF THE LIFETIME OF THE 0.559-Mev LEVEL OF Se^{76} USING NUCLEAR RESONANCE FLUORESCENCE. John R. Pruett (Bryn Mawr Coll., Penna.). Phys. Rev., 129: 2583-90(Mar. 15, 1963).

The lifetime of the 0.559-Mev 2^{+} level of Se^{76} was measured using a nuclear resonance fluorescence technique. In this work a gaseous source of AsH_3 was employed and the 0.559-Mev gamma rays emitted following the beta decay of

As^{76} were scattered from a Se scatterer and from a comparison Zn scatterer. From the difference in the observed scattering, the average resonant scattering cross section for the emitted gamma ray lines was obtained. With an estimate of the ratios of the nuclear matrix elements for the As^{76} beta decay, the fraction $N(E_{res})/N$ of the 0.559-Mev gamma rays having energies that differ by 0.5 ev or less from the resonant energy is computed, and the lifetime of the 0.559-Mev state is calculated. The result obtained is $\tau_{0.559} = (1.55^{+0.13}_{-0.15}) \times 10^{-11}$ sec. In a similar way, an estimate of the lower limit of the lifetime of the 1.216-Mev level of Se^{76} is found to be $\tau_{1.216} > 3 \times 10^{-12}$ sec. (auth)

17212 RANGES AND STOPPING CROSS SECTIONS OF LOW-ENERGY TRITONS. R. L. Wolke (Univ. of Pittsburgh and Univ. of Florida, Gainesville), W. N. Bishop, E. Eichler, N. R. Johnson, and G. D. O'Kelley. Phys. Rev., 129: 2591-6(Mar. 15, 1963).

Stopping cross sections and ranges of tritons as a function of energy from ~0.2 to 2.7 Mev have been measured in polystyrene, nitrogen, air, aluminum, argon, nickel, krypton, and xenon by a coincidence technique utilizing the $Li^6(n,\alpha)H^3$ reaction. The ranges found for 2.736-Mev tritons in these materials are 6.12 ± 0.10, 7.26 ± 0.06, 7.34 ± 0.06, 10.10 ± 0.10, 11.40 ± 0.09, 15.15 ± 0.15, 17.83 ± 0.18, and 20.36 ± 0.20 mg/cm², respectively. Above $E_t/Z \approx 0.05$, the atomic stopping cross section ϵ in ev-cm² is given by $\epsilon \times 10^{15} = 4(E_t/Z)^{-\frac{1}{2}} - (E_t/Z)^{\frac{1}{2}}$, where E_t is the triton energy in Mev and Z is the atomic number of the absorber. The data are compared with stopping theories for the velocity region in which shell effects cause deviations from the simple higher energy stopping theory. (auth)

17213 STUDIES OF DECAY SCHEMES IN THE OSMIUM–IRIDIUM REGION. III. DECAY OF 15.8-HOUR Ir^{186}. G. T. Emery, W. R. Kane, M. McKeown, M. L. Perlman, and G. Scharff-Goldhaber (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 129: 2597-2621(Mar. 15, 1963). (BNL-6507)

The decay of 15.8-h Ir^{186} was studied with a double-focusing electron spectrometer, a lens spectrometer, and scintillation spectrometers. Several coincidence experiments were also performed. About two-thirds of the 101 transitions observed could be fitted into a level scheme for Os^{186} consisting of a ground-state (K = 0) band, a K = 2 (gamma-vibrational) band, and several other levels. The positron spectrum shows at least two branches; the branch with the highest end-point energy (1.94 ± 0.02 Mev) populates the I = 6, K = 0, state at 0.869 Mev. The total positron intensity is (2.5 ± 0.7)%. The most probable spin assignment for Ir^{186} (15.8-h) is 7. Energies of the collective levels of Os^{186}, and relative transition probabilities, are discussed in the framework of the existing knowledge of other even-A osmium isotopes, and are compared with the predictions of the band-mixed strong coupling model and of various versions of the asymmetric rotor model. An appendix gives data accumulated during the course of this work on transitions following the decay of Ir^{185} and of Ir^{187}. (auth)

17214 COLLECTIVE AND INTERPARTICLE INTERACTIONS IN EVEN-EVEN NUCLEI. [PART] II. B. James Raz (State Univ. of New York, Stony Brook). Phys. Rev., 129: 2622-6(Mar. 15, 1963).

The collective model with interparticle interactions included is used to examine the modifications of the vibrational spectra as the strength of (a) the two-particle interaction and (b) the vibration-particle interaction is varied. The E2, M1 mixing ratio δ as well as ratios of γ ray transition probabilities are presented. These results are corrections and extensions of previous work reported. (auth)

17215 BETA-DECAY MATRIX ELEMENTS IN Sb^{122}. F. M. Pipkin, J. Sanderson, and W. Weyhmann (Harvard Univ., Cambridge, Mass.). Phys. Rev., 129: 2626-35 (Mar. 15, 1963).

An electronic computer has been used to investigate the six nuclear matrix elements which enter into the 2^- to 2^+ 1.40-Mev beta transition in the decay of Sb^{122}. Data from beta-gamma angular correlation, beta-circularly polarized gamma angular correlation, nuclear orientation, and nuclear resonance experiments were used in this analysis. As a further aid, the Feenberg-Ahrens relations between certain of the nuclear matrix elements were employed to catalog the solutions and to simplify the search problem. In order to discover how the remaining ambiguity of these solutions could most easily be reduced, for each of the solutions calculations were made of the predicted results of all possible experiments on this beta transition. These calculations show how sufficient experimental data can be obtained to determine unambiguously all six nuclear matrix elements. In an appendix all the theoretical formulas which give the experimental observables for a first forbidden 2^- to 2^+ beta transition in terms of the nuclear matrix elements are summarized. (auth)

17216 ACTIVATION CROSS-SECTION SURVEY OF DEUTERON-INDUCED REACTIONS. Norton Baron and Bernard L. Cohen (Univ. of Pittsburgh). Phys. Rev., 129: 2636-42(Mar. 15, 1963).

A survey was made of activation cross sections for various nuclear reactions induced by 20-Mev deuterons. The (d,p) and (d,t) cross sections increase monotonically with increasing mass number, and in one case (Ni^{58}) the absolute (d,p) cross section is closely predicted by a distorted-wave Born approximation calculation. They are undoubtedly stripping and pickup reactions with little or no compound nucleus contribution. The fact that Coulomb barriers do not affect (d,t) cross sections indicates that the pickup occurs far outside the nucleus. The cross sections for (d,2p) reactions are consistent with a model wherein the second proton is "evaporated" from a compound nucleus, but the level density parameters needed to fit this theory are somewhat lower than expected; this may indicate a contribution from a mechanism in which both protons are emitted in a direct interaction. Excluding the lightest element studied, Cl^{35}, the (d,pα) + (d,αp) activation cross sections are consistent with calculations assuming a reaction path that is predominantly (d,pα) with evaporation of the second particle (i.e., one alpha) from a compound nucleus; however the reaction on Cl^{35} seems to proceed by the path (d,αp) with both particles being evaporated. Cross sections for (d,2n) and (d,nα) reactions in the mass range 60 to 90 indicate that many more low-energy neutrons than low-energy protons are emitted as first particles in deuteron-induced reactions; this indicates that compound nucleus formation is more important than stripping in these reactions. (auth)

17217 INTERACTION MATRIX ELEMENT IN A SHELL MODEL. U. Fano (National Bureau of Standards, Washington, D. C.), F. Prats, and Z. Goldschmidt. Phys. Rev., 129: 2643-52(Mar. 15, 1963).

The matrix elements of two-particle interactions between states of many-particle configurations are expressed as products of one-particle reduced matrix elements and of a single recoupling coefficient. Applications are given to the

Coulomb interaction of $l^n l'$ configurations and to all three-electron configurations. (auth)

17218 DECAY OF Sc^{42m} AND THE LEVELS OF Ca^{42}. Paul C. Rogers and G. E. Gordon (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 129: 2653-9(Mar. 15, 1963). (TID-17285)

A 62.0 ± 0.4-sec isomer, Sc^{42m}, has been observed which decays by emission of a positron group of end-point energy 2.87 ± 0.10 Mev to an excited state in Ca^{42} at 3.191 Mev, followed by a cascade of three γ rays of energies 0.438 ± 0.003, 1.226 ± 0.010, and 1.520 ± 0.010 Mev. The levels of Ca^{42} and their assigned spins are: 1.523 Mev, 2+; 1,836 Mev, 0+; 2.424 Mev, 2+(1+); 2.750 Mev, 4+; and 3.191 Mev, 6+. The spin of Sc^{42m} is 7+. Studies of the reaction $Ca^{40}(He^3,p)$ showed that the first and second excited states of Sc^{42} are at 0.67 ± 0.03 and 1.58 ± 0.05 Mev, respectively, the former being Sc^{42m}. The excitation function for the $Ca^{40}(\alpha,pn)Sc^{42m}$ reaction was also measured. The general trends of levels in even $f_{\frac{7}{2}}$ nuclides are rather well explained by two treatments of the jj-coupling model, with exceptions for Ca^{44} and Ca^{42}. (auth)

17219 LIFETIMES OF 4+ AND 2+ STATES IN THE ROTATIONAL NUCLEI Dy^{160}, Dy^{162}, Er^{166}, Er^{168}, AND Hf^{180}. Angela C. Li and A. Schwarzschild (Brookhaven National Lab., Upton, N. Y.). Phys. Rev., 129: 2664-78(Mar. 15, 1963). (BNL-6508)

Lifetimes of the 2^+ and 4^+ states of the ground-state rotational band were measured for five even-even rare earth nuclei using delayed coincidence techniques. The ratios $B(E2; 4 \rightarrow 2)/B(E2; 2 \rightarrow 0)$ are calculated from these lifetimes using theoretical values for the internal conversion coefficients. In all cases this ratio is in excellent agreement with the value 10/7 predicted by the strong coupling model for rotational nuclei. A measurement of the lifetime of the 2.50-Mev 4+ state of Ni^{60} is also reported. A limit of $\tau_m < 5 \times 10^{-12}$ sec was obtained for this state. (auth)

17220 NEUTRONS FROM PROTON BOMBARDMENT OF LITHIUM. R. R. Borchers and C. H. Poppe (Univ. of Wisconsin, Madison). Phys. Rev., 129: 2679-83(Mar. 15, 1963). (TID-17034)

Relative cross sections for the production of neutrons from the proton bombardment of Li^7 have been measured from 3 to 13 Mev bombarding energy. Time-of-flight spectrometry was used to resolve the groups of neutrons going to various states in Be^7. The cross section for neutrons leaving Be^7 in its ground state shows a peak at 5 Mev and then decreases rapidly as the energy is increased, while the number of neutrons leaving Be^7 in its first excited state decreases fairly uniformly over the whole energy range. The angular distributions for both groups show considerable structure below 6 Mev but become isotropic at higher bombarding energies. From 9 to 13 Mev the zero-degree yield of neutrons leaving Be^7 in its excited state at 4.53 Mev was measured. At the higher proton energies several breakup reactions are energetically possible, but no continuum neutrons from them were observed at 10 Mev bombarding energy. (auth)

17221 OVERLAP AND EXCHANGE EFFECTS IN BETA DECAY. John N. Bahcall (California Inst. of Tech., Pasadena). Phys. Rev., 129: 2683-94(Mar. 15, 1963).

The change in nuclear charge by one unit in beta decay causes initial and final atomic states to overlap imperfectly. The effect of this imperfect overlap on the shape of allowed electron and positron emission spectra is calculated. The calculated change in the spectrum shape can be simulated by including the average excitation energy of the final atom in the energy balance. The inhibition, due to imperfect atomic overlap, of electron-capture rates, as well as total electron and positron-emission rates, is also determined. In all known cases, imperfect atomic overlap increases beta-decay lifetimes by at most a few percent and usually by an amount less than a few tenths of one percent. Antisymmetrization between decay and bound atomic electrons, in conjunction with the change in nuclear charge, gives rise to exchange effects in electron emission and electron capture. Due to exchange terms, the usual allowed electron spectrum is multiplied by a quantity that is of the order of $1 - 2Z^{-1}$ for energies less than the binding energy of a K electron in the initial atom. This exchange correction is negligible for higher energies of the emitted continuum electron. A simple approximate formula is derived that predicts the effect of exchange on L to K capture ratios; this formula predicts a 22% increase over the usual theoretical value for the L to K ratio of Ar^{37}. The Ar^{37} prediction is in excellent agreement with recent experiments and with a more complicated calculation by Odiot and Daudel. Exchange effects change total electron emission and electron capture rates by at most a few percent. (auth)

17222 AVERAGE RADIATIVE CAPTURE CROSS SECTIONS FOR 30- AND 65-kev NEUTRONS. R. L. Macklin, J. H. Gibbons, and T. Inada (Oak Ridge National Lab., Tenn.). Phys. Rev., 129: 2695-7(Mar. 15, 1963).

Neutron radiative capture cross sections near 30 and 65 kev have been measured for a large number of elements by means of a large liquid scintillator and a pulsed neutron source. The results show definitive even vs odd A effects as well as systematic variations due primarily to effects of nuclear shells. Calculations of the scintillator efficiency for various capture γ ray cascade modes are in good agreement with experimental results. (auth)

17223 ALPHA-PARTICLE SPECTRA PRODUCED IN THE REACTIONS OF DEUTERONS ON Li^7. P. Paul and D. Kohler (Stanford Univ., Calif.). Phys. Rev., 129: 2698-2704(Mar. 15, 1963).

The alpha particle spectra from the Li^7 + d reactions were determined for deuteron energies from 0.7 to 3.0 Mev. Alpha particle groups resulting from the breakup of Be^9 and Be^8 are identified. In the excitation functions of the different groups, states in Be^9 are seen at E_d = 1.75 and 2.5 Mev, and in Be^8 at E_d = 2.05 Mev and probably also at 2.5 Mev. They are presumably to be identified with the states at 18.1 and 18.6 Mev in Be^9 tentatively assumed from earlier work and the states at 16.62 and 16.92 Mev in Be^8 as also seen in earlier work. (auth)

17224 FISSION PRODUCT YIELDS IN HELIUM ION-INDUCED FISSION OF Au^{197}, Pb^{204}, AND Pb^{206} TARGETS. E. F. Neuzil and A. W. Fairhall (Univ. of Washington, Seattle). Phys. Rev., 129: 2705-10(Mar. 15, 1963).

Mass-yield curves were measured radiochemically for fission of Au^{197}, Pb^{204}, and Pb^{206} target nuclei bombarded with 41.9-Mev helium ions. Fission is symmetric in all three cases, the data being satisfactorily represented by Gaussian-shaped curves with full widths at half-maximum of 30, 27, and 24 mass units, respectively. The widths at half-maximum, $W_{\frac{1}{2}}$, of a number of cases of fission in the symmetric mode are examined and it is shown that the widths appear to be correlated with the excitation energy $E_{S.P.}$ which the fissioning nucleus possesses at the saddle point. Over the excitation energy interval 10 – 23 Mev the data follow the empirical expression $W_{\frac{1}{2}} = E_{S.P.} + 7$. (auth)

17225 ANGULAR DISTRIBUTION OF FRAGMENTS FROM FISSION INDUCED BY HEAVY IONS IN GOLD AND

BISMUTH. Victor E. Viola Jr., T. Darrah Thomas, and Glenn T. Seaborg (Univ. of California, Berkeley). Phys. Rev., 129: 2710-17(Mar. 15, 1963).

Measurements of the angular distribution of fission fragments produced by irradiation of Au^{197} and Bi^{209} with various heavy ions were presented. The projectiles (B^{11}, C^{12}, N^{14}, and O^{16}) had energies from a few Mev above the Coulomb barrier to 10.4 Mev per nucleon. The gross features of these results could be explained by use of a model and parameters originally developed to account for angular distributions of fission fragments from helium-ion bombardments. In detail, however, these results indicated that the models used to predict the average value of the angular momentum of the compound nucleus gave values too low near the Coulomb barrier. Furthermore, at high bombarding energies it was necessary to consider the fact that appreciable direct interaction was taking place. (auth)

17226 DIRECT (p,n) REACTION IN MEDIUM A NUCLEI: A CONFIGURATION-SELECTIVE PROCESS. J. D. Anderson, C. Wong, and J. W. McClure (Univ. of California, Livermore). Phys. Rev., 129: 2718-22(Mar. 15, 1963). (UCRL-7059)

Time-of-flight techniques were used on the Livermore variable energy cyclotron to study (p,n) spectra from selected target nuclei. Previously reported neutron spectra for 14.8-Mev protons all showed one strong neutron group at an energy corresponding in excitation in the final nucleus to the isobaric counterpart (analog state) of the target ground state, i.e., the Q value being the Coulomb displacement energy. With the increase in cyclotron energy to 18.5 Mev, measurements of isobaric ground states were extended to include Rh^{103}, Ag, In^{115}, Sn, and Pr^{141}. The measured width of the isobaric state was less than 100 kev even for elements as heavy as Ag and Sn where the Coulomb displacement energy was ≈13.5 Mev. Excited isobaric states were found in bombarding even-even nuclei from Ar^{40} to Se, in correspondence with the excited states of the target nucleus. No such prominent excited states were observed in odd-even target nuclei V^{51} and Co^{59}. For the "deformable" odd-even nuclei Rh^{103} and Ag, excited isobaric states were observed corresponding to states in the target nucleus with large Coulomb excitation cross sections. Prominent high-energy neutron groups were observed corresponding to predicted configuration states. (auth)

17227 PHOTONEUTRON CROSS SECTIONS OF Ta^{181} AND Ho^{165}. R. L. Bramblett, J. T. Caldwell, G. F. Auc Auchampaugh, and S. C. Fultz (Univ. of California, Livermore). Phys. Rev., 129: 2723-9(Mar. 15, 1963). (UCRL-6983)

The (γ,n) and $(\gamma,2n)$ cross sections for Ta^{181} and Ho^{165} were measured by use of nearly monochromatic photons obtained from the annihilation-in-flight of fast positrons. The integrated cross sections up to 28 Mev for $\sigma(\gamma,n)$ and $\sigma(\gamma,2n)$, respectively, are 1.32 ± 0.13 and 0.93 ± 0.09 Mev·b for Ta, and 1.47 ± 0.15 and 0.90 ± 0.09 Mev·b for Ho. Values obtained for σ_{-2} are 10.88 and 10.93 mb/Mev, respectively, for these elements. The level density parameters, a, were determined to be 15.7 and 22.0 reciprocal Mev, respectively. The intrinsic quadrupole moments determined from the compound nucleus formation cross sections, were found to be 6.71 ± 0.74 and 7.40 ± 0.90 b for Ta and Ho, respectively. (auth)

17228 PROPAGATION OF THE SINGLE-SCATTERING DISTRIBUTION IN MULTIPLE SCATTERING: MUON SCATTERING IN IRON. Norris A. Nickols and Walter H. Barkas (Univ. of California, Berkeley). Phys. Rev., 129: 2738-43(Mar. 15, 1963). (UCRL-10306)

The moments of the projected angular distribution of the single-scattering process are shown to be derivable from the emergent angular distribution of a beam that has traversed a thick absorber. Since very small deflections do not contribute to the observed moments, ambiguity is avoided by adopting a formulation of the electronic screening that leads to a definite total scattering cross section. The theory is applied to an experiment in which 2-Bev muons are incident to an iron scatterer 18 in. thick. The observed angular distribution is analyzed. It is shown that the nuclear electromagnetic form factor derived from the muon data is consistent with that found from electron scattering, and is completely incompatible with a point-nucleus model. (auth)

17229 OBSERVABLE HYPERFINE EFFECTS IN MUON CAPTURE BY COMPLEX NUCLEI. Roland Winston (Univ. of Chicago). Phys. Rev., 129: 2766-85(Mar. 15, 1963).

The capture rates, $\Lambda_{\pm}^{c,nP}$, of the two hyperfine states of $F_{\pm}$ of the $(p\mu)$ atom are, in general, expected to be different (spin dependence of muon capture). This difference depends quantitatively on the details of the interaction Hamiltonian, being maximum for an F−GT (i.e., V−A type) interaction. An experimental comparison for the $(p\mu)$ system appears at present difficult, but related spin dependence effects will be exhibited by bound protons, i.e., complex nuclei. Observable hyperfine (hf) effects of this kind are summarized. The character of such effects is dominated by the rate R at which the upper hf state can be converted into the true ground state (through an M1 Auger process). A detailed calculation of R is given for all cases of practical interest. A variety of possible experiments are discussed. The considerations show that F^{19} constitutes the ideal target, leading to the largest and most readily analyzable effects. Three experiments were performed with this target, viz., measured (1) the time distribution of the neutral capture products, (2) the asymmetry of the decay electrons, and (3) the time distribution of the latter; these measurements are described and analyzed. It is concluded on the basis of measurements (1) and (3) that the interaction is definitely of the F−GT (as opposed to F + GT) type, assuming that both F and GT interactions are present. Invoking independent observations on muon capture by complex nuclei, this assumption becomes redundant, and we may conclude that the universal Fermi interaction ("V−xA") is implied by the results. This conclusion is in agreement with recent results on muon capture in liquid hydrogen. The conversion rate observed in experiments (1) and (3) ($6.1 \pm 0.7\ \mu sec^{-1}$) agrees with the prediction ($R = 5.8\ \mu sec^{-1}$), which is qualitatively confirmed by experiment. (auth)

17230 MODERATION AND ABSORPTION TIMES OF NEGATIVE PIONS IN LIQUID HYDROGEN. J. H. Doede (Argonne National Lab., Ill. and Univ. of Chicago), R. H. Hildebrand, M. H. Israel, and Manfred R. Pyka. Phys. Rev., 129: 2808-11(Mar. 15, 1963). (TID-17794)

Among 546,000 negative pions stopping in a liquid hydrogen bubble chamber, 21 events were found corresponding to pion-muon decay in the backward hemisphere from a velocity ≤0.006c. Analysis gives $(2.3 \pm 0.6) \times 10^{-12}$ sec as the mean time for a pion to go from this velocity to nuclear capture. Results are also presented for the moderation time of pions between velocities 0.1c and 0.006c. (auth)

17231 OBSERVATIONS ON THE ENERGIES OF SINGLE-PARTICLE NEUTRON STATES. Bernard L. Cohen (Univ. of Pittsburgh). Phys. Rev., 130: 227-34 (Apr. 1, 1963).

The available information on location of neutron single-particle levels is analyzed and the following conclusions

are reached: (1) There is strong evidence that the depth of the shell-model potential well varies with symmetry energy, getting shallower as the neutron excess increases. (2) There is a stronger than average interaction between nucleons with the same orbital angular momentum; this causes a level to move down in energy as it fills (self-binding effect), or as a proton state of the same l fills, but the effect seems to be weaker on the $(l - \frac{1}{2})$ neutron state as the $(l + \frac{1}{2})$ neutron state fills. (3) Spin-orbit splittings are extra large when the members of the doublet are in different shells, one full and the other empty; this is attributed to the self-binding effect. (4) The rate of change of binding energy with mass number for a given level, dE/dA, is considerably smaller than calculations would indicate; this may be explained as a decrease in potential well depth with A, or as a velocity dependence giving an effective mass of nucleons in nuclei somewhat larger than the free nucleon mass. (5) The spacings between oscillator shells are somewhat smaller than in the harmonic oscillator potential, and in available calculations for a Saxon potential; this again may indicate an effective mass greater than the free nucleon mass. (6) The l dependence of the energies of shell model levels is much smaller than given by Nilsson when the levels are empty, but the Nilsson term gives reasonable agreement when the levels are full; this indicates that the self-binding effect increases with increasing l. All of these effects are discussed and quantitative estimates of their magnitudes are given. (auth)

17232 STUDIES OF LOW-LYING LEVELS OF ERBIUM AND TUNGSTEN ISOTOPES WITH (d,p) REACTIONS. Akira Isoya (Univ. of Pittsburgh). Phys. Rev., 130: 234-44(Apr. 1, 1963).

Natural metal targets of erbium and tungsten and separated isotope targets of W^{182} and W^{183} were bombarded with an energy-analyzed 15-Mev deuteron beam and energy spectra of outgoing protons from the stripping reaction were taken using a precision magnetic analyzer and photographic plates. Ground-state rotational bands of even-even nuclei Er^{168} and W^{184} were observed in the highest energy region of the respective spectra. Relative intensities and angular distributions for different rotational levels agreed reasonably well with the predictions from the stripping reaction theory using the Nilsson eigenfunction for the captured neutron orbit. The next highest energy proton groups were assigned to the intrinsic two-quasiparticle or phonon excitation levels of the above even-even nuclei, on the basis of peak positions, yields, and angular distributions. Transition rates to the so-called γ-vibrational states were found quite high. Several prominent peaks with smaller Q values were interpreted as due to those levels of the odd-A isotopes that were associated with the Nilsson eigenstates involving low orbital angular momenta. The absolute cross sections for almost all transitions studied agreed with the predicted ones, using the distorted-wave Born approximation and the pairing interaction theory, within an accuracy of a factor of two or three. (auth)

17233 INELASTIC ELECTRON SCATTERING STUDIES: Cu^{63}, In^{115}, Ta^{181}, Pb^{208}, and Bi^{209}. H. W. Kendall and Jan Oeser (Stanford Univ., Calif.). Phys. Rev., 130: 245-58 (Apr. 1, 1963).

Measurements were made of the cross sections for scattering of electrons of primary energies from 183 Mev to 600 Mev from Cu^{63}, In^{115}, Ta^{181}, Pb^{208}, and Bi^{209}, using high-resolution detectors. A number of E2, E3, E4, and two E5 transitions were induced with nuclear excitations up to 7 Mev. The levels excited have enhanced gamma-decay rates to the nuclear ground states. In the odd-A nuclei most of the observed transitions were to clusters of near-similar states. The results are compared in detail to studies of (p,p'), (d,d'), (α,α'), and (n,n') reactions in the same nuclei. Great similarities between these and the (e,e') are established. It is shown how the combined results can be used to determine the disposition and intensities of the levels within the clusters and how these are related to the discrete-energy core excitations in neighboring even-even nuclei. Data taken at high momentum transfer show that inelastic electron scattering continues to be dominated by excitation of collective states in disagreement with predictions based on present understanding of the process. Excitations seen in both Bi^{209} and Pb^{208} at about 5.8 Mev are identified as leading to collective states in these nuclei. They are probably E5 transitions although E4 assignments cannot be excluded. The collective states are not seen in Ta^{181} and Au^{197} in (e,e'). (auth)

17234 NUCLEAR EXCITATION FUNCTIONS: Ar^{40}, $Zn^{68}(d,He^3)$. David C. Williams and John W. Irvine, Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 130: 259-64(Apr. 1, 1963). (TID-17301)

The (d,He^3) reaction was studied by radiochemical techniques. Absolute excitation functions were determined to 15 Mev for the reactions $Ar^{40}(d,He^3)Cl^{39}$ and $Zn^{68}(d,He^3)Cu^{67}$. The $Ar^{40}(d,He^3)Cl^{39}$ cross section is 0.37 ± 0.07 mb at 14.8 Mev and the $Zn^{68}(d,He^3)Cu^{67}$ cross section is 0.54 ± 0.08 mb at 15.4 Mev. These cross sections are shown to be more than an order of magnitude greater than predicted by the statistical model of nuclear reactions. The energy dependence of the cross section appears to be governed by the Coulomb barrier felt by the outgoing He^3 particle, at least when the He^3 energy is less than the classical barrier height. The shape of the observed excitation functions may be reproduced moderately accurately by a very simple proton pickup model. (auth)

17235 NUCLEAR EXCITATION FUNCTIONS AND THICK-TARGET YIELDS: Zn + d AND $Ar^{40}(d,\alpha)$. David C. Williams and John W. Irvine, Jr. (Massachusetts Inst. of Tech., Cambridge). Phys. Rev., 130: 265-71(Apr. 1, 1963). (TID-17299)

Radiochemical techniques were used to determine partial or complete excitation functions to 15 Mev for the reactions $Ar^{40}(d,\alpha)Cl^{38}$, $Zn^{66}(d,\alpha)Cu^{64}$, $Zn^{64}(d,\alpha n)Cu^{61}$, $Zn^{67}(d,\alpha n)Cu^{64}$, $Zn^{64}(d,2p)Cu^{64}$, and $Zn^{67}(d,2p)Cu^{67}$. The results were compared with the predictions of the statistical model of nuclear reactions. Most features of the (d,α) and $(d,\alpha n)$ excitation functions measured are consistent with the predictions of the model. The $Zn^{67}(d,2p)Cu^{67}$ reaction appears to take place essentially by a direct process, while the $Zn^{64}(d,2p)Cu^{64}$ reaction, that has a much higher cross section, agrees with the model. Support is found for a rather large value of the nuclear radius parameter, $r_0 = 1.7$ F. Excitation functions are presented for the reactions $Zn^{64}(d,p)Zn^{65}$ + $Zn^{64}(d,n)Ga^{65}(\beta^+)Zn^{65}$, $Zn^{66}(d,n)Ga^{67}$, and $Zn^{66}(d,2n)Ga^{66}$. Thick-target yields from deuteron bombardment of metallic zinc are given for Cu^{61}, Cu^{64}, Cu^{67}, Zn^{65}, Ga^{66}, and Ga^{67}. (auth)

17236 SOME N^{12} AND B^{12} BETA-DECAY MEASUREMENTS. R. W. Peterson and N. W. Glass (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 130: 292-8(Apr. 1, 1963). (LADC-5562)

The branching fractions of the B^{12} and N^{12} beta decays to the 4.43-Mev level of C^{12} were determined to be $(1.3 \pm 0.1)\%$ and $(2.4 \pm 0.2)\%$, respectively, by means of $\beta\gamma$-coincidence measurements. The B^{12} and N^{12} half-lives were remeasured,

using a beta-ray spectrometer to identify the emitted beta particles, and found to be 20.2 ± 0.2 msec and 11.0 ± 0.1 msec, respectively. The thin-target cross section curve for the $B^{10}(He^3,n)N^{12}$ reaction was measured over the energy range from 2.0 to 6.3 Mev. Using the above half-lives and branching ratios, the ratio of the N^{12} to B^{12} ft values for transitions to the 4.43-Mev level of C^{12} was calculated to be 0.92 ± 0.06. With the use of published data and the above half-lives, the ratio of ft values of the N^{12} to B^{12} ground-state transitions was calculated to be 1.16 ± 0.03. Thus, there appears to be a significant difference in the B^{12} and N^{12} ground-state transition ft values. (auth)

17237 DIRECT COMPARISON OF THE B^{12} AND N^{12} BETA SPECTRA. Neel W. Glass and Robert W. Peterson (Los Alamos Scientific Lab., N. Mex.). Phys. Rev., 130: 299-305(Apr. 1, 1963).

An experimental direct comparison of the shapes of the B^{12} and N^{12} beta decay spectra was made as a test of the validity of the conserved vector current theory (CVCT). The comparison was made at corresponding momentum points normalized to the end-point momenta of the spectra using a 5-channel 180° magnetic spectrometer. The comparative shape factor was measured to have an energy dependence of 1.62 ± 0.28% per Mev, to be compared with a predicted value of 1.10 ± 0.17% per Mev on the basis of the CVCT. The measured end-point energy of the N^{12} ground-state spectrum is 16.384 ± 0.015 Mev. The comparison of the spectra also yielded a value of 2.2 ± 0.6% for the branching fraction of the N^{12} decay to the 7.6-Mev level of C^{12}, 0.85 ± 0.6% for the fraction to the 10.1-Mev level, and an indication of a branch to one or more levels around 12 Mev. (auth)

17238 INTERNAL CONVERSION COEFFICIENTS IN THE DECAY OF Au^{199}. R. L. Hahn and W. S. Lyon (Oak Ridge National Lab., Tenn.). Phys. Rev., 130: 306-8 (Apr. 1, 1963).

The intensities of the γ rays and electron shell vacancies in the decay of Au^{199} were measured by differential γ-ray spectrometry and 4π β-γ coincidence counting. These intensities, per Au^{199} disintegration, are 0.368 ± 0.011, 0.0774 ± 0.0022, and 0.0031 ± 0.0015 for the 0.158-, 0.209-, and 0.051-Mev γ rays, respectively, and 0.208 ± 0.014 and 0.176 ± 0.005 for the L- and K-shell vacancies, respectively. Internal conversion coefficients, obtained from these data and the relative conversion electron yields of Nall, Baird, and Haynes, are: in the K shell, 0.317 ± 0.013 and 0.768 ± 0.032 for the 0.158- and 0.209-Mev γ rays, respectively; and in the L shell, 0.464 ± 0.039, 0.139 ± 0.012, and 8.5 ± 4.1 for the 0.158-, 0.209-, and 0.051-Mev γ rays, respectively. These values are consistent with the internal conversion coefficients calculated by Rose. The intensities computed from the data for the 0.251-, 0.302-, and 0.460-Mev β-particle transitions are 0.189 ± 0.005, 0.680 ± 0.025, and 0.131 ± 0.025, respectively. (auth)

17239 LEVEL STRUCTURE OF Ni^{64} AND Zn^{64}. J. Benveniste (Univ. of California, Livermore), A. C. Mitchell, and C. B. Fulmer. Phys. Rev., 130: 309-11(Apr. 1, 1963). (UCRL-7122)

The energy spectra of inelastically scattered protons that lead to excited levels in Ni^{64} and Zn^{64} were measured at incident proton energies of 9.6 and 11.7 Mev. The excitation energies of ten levels of Ni^{64} below 4.4 Mev and fourteen levels of Zn^{64} below 4.7 Mev were measured. (auth)

17240 Σ^- CAPTURE IN DEUTERIUM. Donald E. Neville (Univ. of Chicago). Phys. Rev., 130: 327-40 (Apr. 1, 1963).

Transition rates for the final states $\Sigma^0 + n + n$ and $\Lambda + n + n$ are calculated in impulse approximation for Σ^-d capture from rest, taking into account the $^1S_0$ n-n attraction and the tensor term in the $\Sigma^-p \rightarrow \Lambda n$ transition amplitude. Using the $\Sigma^-p \rightarrow \Sigma^0 n$ and $\Sigma^-p \rightarrow \Lambda n$ amplitudes calculated for global symmetry by de Swart and Dullemond, the branching ratio $\Sigma^0/(\Sigma^0 + \Lambda)$ obtained is 0.24, compared with the observed ratio 0.037 ± 0.022. The uncertainties in the comparison between the observed and calculated ratios are discussed in detail, especially those concerned with the validity of the impulse approximation, in view of the near-resonant ΣN interaction in the global symmetry model, and the question of the appropriate form of the spin average, in view of the strong electromagnetic spin-orbit forces in the Σ^-d atom. It is concluded that the appropriate spin average is $\frac{2}{3}[\Sigma^0/(\Sigma^0 + \Lambda)]_{S=3/2} + \frac{1}{3}[\Sigma^0/(\Sigma^0 + \Lambda)]_{S=1/2}$ within corrections of about 10%. Agreement with the experimental ratio appears unlikely with global symmetry, even when these uncertainties are taken into account. (auth)

17241 EQUILIBRIUM CONFIGURATION AND FISSION BARRIER FOR LIQUID DROP NUCLEI WITH HIGH ANGULAR MOMENTUM. Daniel Sperber (Armour Research Foundation, Chicago). Phys. Rev., 130: 468-77(Apr. 1, 1963).

The equilibrium shape and the fission barrier are calculated for the entire range of angular momenta for which a rotating droplet held together by surface tension has a stable equilibrium. A liquid drop which is originally spherical takes the shape of an oblate spheroid as the angular momentum increases. At higher angular momenta the shape becomes concave at the poles and a ring form is created. It is shown that the equilibrium ceases to be stable at or near the critical angular momentum at which this change of topology occurs. (auth)

17242 A 2.8 HOUR RHENIUM ISOTOPE. G. B. Baró and J. Flegenheimer (Comisión Nacional de Energia Atómica, Buenos Aires). Radiochim. Acta, 1: No. 1, 2-3(Sept. 1962). (In English)

A rhenium isotope of 2.8 hours was produced by irradiating iridium or osmium with fast neutrons. Arguments are given for assigning this activity to the mass number 190. (auth)

17243 SEARCH FOR THE ISOMERS Sr-89m AND Sr-91m. J. Flegenheimer, M. E. Huergo, and R. Radicella (Comisión Nacional de Energia Atómica, Buenos Aires). Radiochim. Acta, 1: No. 1, 47(Sept. 1962). (In German)

Experiments were carried out to determine if isomers exist for Sr^{89} and Sr^{91}. For a half life of 51 days no further half lives were observed for Sr^{89} between 1 and 30 days. For Sr^{91}, in observations from 8 min to 10 days, half lives of 8 min, 2.9 hr, and 9.7 hr were observed. (M.C.G.)

17244 POLARIZATION PHENOMENA IN DIRECT NUCLEAR REACTIONS TAKING INTO ACCOUNT SPIN-ORBITAL INTERACTION. A. G. Sitenko and V. F. Kharchenko (Karkov State Univ.). Ukr. Fiz. Zh., 7: 1149-59 (Nov. 1962). (In Ukrainian)

Polarization phenomena in direct nuclear reactions were considered with redistribution of the particles (stripping reactions and reaction of capture with deuteron formation) taking into account spin-orbital interaction. General formulas were obtained for angular distributions and polarizations of the products of the stripping and capture reactions under the action of polarized particles on arbitrarily orientated nuclei. A number of simple relations are established between the sections for various processes and the

polarizations of the particles participating in these processes. (auth)

17245 ANGULAR DISTRIBUTION OF α-PARTICLES FROM $Be^9(d,\alpha)Li^7$ REACTIONS. P. G. Ivanitskii (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 7: 1160-4(Nov. 1962). (In Ukrainian)

The angular distributions of α particles from $Be^9(d,\alpha)Li^7$ reactions for the ground and excited states of Li^7 were obtained at 13.6 Mev deuteron energy. The experimental angular distributions are compared with the direct interaction theory. The direct interaction process is shown to play a significant part in the reaction mechanism at a given deuteron energy. The pick-up mechanism seems to predominate somewhat over the direct knock-out process. (auth)

17246 ELASTIC SCATTERING OF NEUTRONS BY NONSPHERICAL NUCLEI WITH A ROTATIONAL SPECTRUM. V. S. Olkhovskii and Yu. V. Tsekhmistrenko (Shevchenko State Univ., Kiev and Inst. of Physics, Academy of Sciences, Kiev). Ukr. Fiz. Zh., 7: 1265-70 (Dec. 1962). (In Ukrainian)

Using Schroedinger's effective one-particle equation with a nonlocal potential operator, the problems of the elastic scattering of neutrons by nonspherical nuclei with a pronounced rotational spectrum were solved. The model under consideration primarily describes direct interaction, while the effect of the formation of a compound nucleus is taken into account by introducing surface absorption of neutrons. A comparison is made with experiment and a simple optical model. The results of the computations agree much better with the experiment than in the case of an optical model. (auth)

17247 SPLITTING OF A DEUTERON IN A FIELD OF DEFORMED NUCLEI. E. Ismatov (Inst. of Physics, Academy of Sciences, Kiev). Ukr. Fiz. Zh., 7: 1271-3 (Dec. 1962). (In Ukrainian)

As is known, a number of light nuclei (with mass numbers $A \approx 18$ and $19 \leq A \leq 28$) are characterized by large statical deformations. It is therefore necessary to take into account nonsphericity of the nuclei on considering direct processes. Splitting of the deuteron, attended by excitation of the rotation state of the nucleus is, apparently, possible during the interaction of a deuteron with a nonspherical nucleus. Differential sections of deuteron splitting with excitation of the nucleus were obtained. (auth)

17248 INELASTIC SCATTERING OF NEUTRONS BY NONSPHERICAL NUCLEI WITH A ROTATIONAL SPECTRUM. V. S. Olkhovskii and Yu. V. Tsekhmistrenko (Shevchenko State Univ., Kiev and Inst. of Physics, Academy of Sciences, Kiev). Ukr. Fiz. Zh., 7: 1363-4 (Dec. 1962). (In Ukrainian)

Inelastic scattering of neutrons by nonspherical nuclei with pronounced rotational spectra was analyzed. An equation was developed for 2.8-Mev inelastic scattering on Mg^{24} with a first rotational spectrum at $\epsilon_1 = 1.37$ Mev. The obtained parameters ($\gamma = 0$, $\beta_{eff} = 0.35$, $v_0 = 51$ Mev, $W = 0.155$, and $R_0 = 1.45$) were identical to those obtained by V. S. Olkhovskii (Ukr. Fiz. Zh., 7: No. 12, 1265(1962)). (R.V.J.)

17249 ENERGY DISTRIBUTION OF α-RECOIL NUCLEI IN FORMVAR. P. Zahn (Technische Hochschule, Munich). Z. Physik, 172: 85-98(1963). (In German)

The energy distribution curve of the recoil nuclei from Po^{212} α decay (energy of origin 169 kev) after their passage through formvar films between 1.4 and 7.0 $\mu g/cm^2$ thick was ascertained with the help of an electronic transmission time measurement. The spectra showed for the thin films a strongly asymmetric form, which could be explained qualitatively by means of the very small average number of collisions. A Gaussian distribution was not attained up to film thicknesses to half range. From the energy distribution curve the average energies were determined as a function of the traversed layer thickness. If the energy loss by means of ionization is considered to be about 10% the results attain energy-range curves in agreement with those of Lindhard and Scharff. (tr-auth)

17250 INVESTIGATION OF THE X RADIATION IN NUCLEAR FISSION OF U^{235}. H. Hohmann (Technische Hochschule, Munich). Z. Physik, 172: 143-62(1963). (In German)

At the Munich Research Reactor proportional and scintillation detectors were used to investigate the x-ray spectra that was emitted in the thermal fission of U^{235}. The K x-ray spectra showed an energy distribution with maxima at 16 and 30.5 kev. From that the most probable nuclear charge, Zp, the primarily formed fission fragments, and the relative half-width $\Delta Z/Z$ of the primary nuclear charge distribution were ascertained. The total intensity of the K x radiation was determined to be 0.2 ± 0.06 K quanta per fission. In the region of the L x radiation the fission products below 6 kev were detected in addition to μ x radiation from uranium, which originated by means of excitation processes in deceleration of the fission fragments in fission foils. The investigation of the dependence on time of the emitted K x radiation from the moment of fission showed the appearance of delayed radiation up to 0.3 μsec after the fission event. (tr-auth)

17251 DECAY SCHEME AND MATRIX ELEMENTS FOR THE β TRANSITION $Ag^{110m} \rightarrow Cd^{110}$. H. Daniel, O. Mehling, and D. Schotte (Max-Planck-Institut für Kernphysik, Heidelberg). Z. Physik, 172: 202-9(1963). (In German)

The β decay $Ag^{110m} \rightarrow Cd^{110}$ was investigated with a double lens spectrometer and a β-γ circular-polarization correlation setup. The shape of the $6^+ \rightarrow 6^+$ β spectrum with $E_0 = 529$ kev was found to be allowed, in disagreement with earlier work. The constant A of the β-γ circular-polarization correlation was measured to be $A = 0.07 \pm 0.02$. This implies a ratio X of Fermi to Gamow-Teller contribution to the decay of $X_1 = -0.02 \pm 0.03$ or $X_2 = -10.3^{+2.3}_{-1.1}$. Qualitative shell model considerations favor the value X_1. Additional information is given for the disintegration schemes of Ag^{110m} and Ag^{110}. (auth)

17252 MAGNETIC MOMENT AND QUADRUPOLE MOMENT OF THE 8.42-kev STATE of Tm^{169} FROM THE HYPERFINE STRUCTURE SPLITTING IN Tm METAL. M. Kalvius, P. Kienle, H. Eicher, W. Wiedemann, and C. Schueler (Technische Hochschule, Munich). Z. Physik, 172: 231-8(1963). (In German)

The hyperfine transition from the 8.42 kev level to the groundstate of Tm^{169} was investigated using the Mössbauer-Effect in Tm-metal in the temperature range between 5 and 60°K. Well resolved hyperfine spectra were found between 5 and 25°K indicating an internal magnetic field of about 7×10^6 Oe and a large electric fieldgradient. The ratio of the magnetic moments of the 8.42 kev rotational state to the groundstate $\mu_e/\mu_g = -2.33 \pm 0.04$ was deduced from these measurements. The magnetic moment of the groundstate and the quadrupole moment of the 8.42 kev level were deduced from calculated internal fields. These data were analyzed in terms of the "Unified Nuclear Model" and the results compared with other known magnetic moments and M-1-transition probabilities in the $K = 1/2$ rotational band of Tm^{169}. The complicated hyperfine spectra obtained above

25°K reveal the influence of complex magnetic ordering on the internal fields in Tm-metal. (auth)

17253 A METHOD FOR PRODUCTION OF BEAMS OF NEGATIVE IONS. W. Gentner and G. Hortig (Max-Planck-Institut für Kernphysik, Heidelberg). Z. Physik, 172: 353-7(1963). (In German)

A method for the production of beams of negative ions to be injected into a tandem Van de Graaff accelerator is presented. Negative ions of a desired species are produced by impact of noble gas ions with molecules of a gas containing this element, and are then collected and bent into a beam with high efficiency. For example, a beam of negative fluorine ions was obtained by bombardment of boron fluoride with 30-kev krypton ions, resulting in a current of 0.5 μA of F^{4+} at the target. The original ion source of the tandem was used with this modified procedure. The krypton gas was fed into the duoplasmatron and boron fluoride into the charge exchange channel. No damage to the ion source system was observed, even in this case. This method was also applied to nitrogen and oxygen with good results. Some measurements are reported, and a discussion of the basic process of the method is given. (auth)

17254 A QUALITATIVE DISCUSSION ON THE COLLECTIVE POTENTIAL ENERGY IN THE QUASI-SPIN MODEL. Walter Greiner (Universität, Freiburg i. B.). Z. Physik, 172: 386-401(1963). (In German)

The collective potential-energy surface was calculated for a simple nuclear model consisting of a closed core and one j-shell. This shell can be filled up by one sort of nucleons (protons or neutrons). The residual force acting between nucleons consists of a pairing- and a quadrupole-force. In the quasi-spin-formalism, proposed by A. K. Kerman, the parameters of the collective potential energy are calculated and the collective features of even-even nuclei were discussed qualitatively. (auth)

17255 COMPARISON OF THE SPECTRA OF γ-RAYS EMITTED IN THE RADIATIVE CAPTURE OF THERMAL AND FAST NEUTRONS. A. T. Bakov, S. P. Belov, Yu. A. Kazasskii, and V. I. Popov. Zh. Eksperim. i Teor. Fiz., 44: 3-9(Jan. 1963). (In Russian)

Apparatus spectra of γ rays produced in radiative capture of neutrons from a uranium-water reactor are presented. Measurement of the γ ray spectra was performed at energies above 3–4 Mev for Mn, Co, Fe, Ni, and Cu with a single crystal scintillation γ-spectrometer. The results of the measurements are compared with the spectra of γ rays produced in radiative capture of thermal neutrons under identical geometrical conditions. (auth)

17256 SOME REGULARITIES IN α-DECAY OF NUCLEI WITH LESS THAN 126 NEUTRONS. B. N. Belyaev, A. V. Kalyamin, and A. N. Murin. Zh. Eksperim. i Teor. Fiz., 44: 10-13(Jan. 1963). (In Russian)

The ratio of the α decay probability to the total decay (α decay plus E capture) probability, $\alpha/(\alpha + E)$, is experimentally determined for Po^{204}. Coefficients a and b in the linear dependence for polonium isotopes with $N < 126$ are determined. The values of $\alpha/(\alpha + E)$ for $Po^{196,198,200}$ isotopes are estimated on the basis of this linear relation. Values of the reduced derivative widths δ_L^2 which characterize the probability of α particle formation are calculated for these isotopes on the basis of the value of $T_{1/2}(\alpha)$. The forbiddenness coefficients for a number of α-transitions are determined for even-odd Po isotopes. (auth)

17257 ON UNPAIRED COLLISIONS IN THE INTERACTION OF SLOW POSITIVE IONS WITH THE SURFACE OF A METAL. V. I. Veksler (Tashkent State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 44: 14-16(Jan. 1963). (In Russian)

The maximal energies of Rb^+ and Cs^+ ions scattered by a molybdenum target in a direction forming an angle of 120° with respect to the direction of motion of the primary ions are investigated. The data can be interpreted from the concept of primary ion scattering from four target atoms (their velocities $v_0 > 1.4 \cdot 10^8$ cm/sec) and from the lattice as a whole for $v_0 < 1.4 \cdot 10^8$ cm/sec). (auth)

17258 SPINS AND PARITIES OF SOME STATES OF MOLYBDENUM ISOTOPES. N. I. Zaika, O. F. Nemets, and V. V. Tokarevskii (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 44: 17-21(Jan. 1963). (In Russian)

The angular distributions of protons from the (d,p) reactions on $Mo^{92,94,95,96}$ isotopes are measured for 13.6-Mev deuterons. By comparing with the Butler theory, values of the angular momenta l_n for neutron capture in the ground and first excited states of the $Mo^{93,95,96,97}$ nuclei are obtained, and possible values of the spins and parities of these states are determined. (auth)

17259 POSITRON DECAY OF Re^{182}. N. B. Badalov, S. S. Vasilenko, M. G. Kaganskii, D. L. Kaminskii, and M. K. Nikitin (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 35-40(Jan. 1963). (In Russian)

Positron emission during the decay of two Re^{182} isomers has been detected. The positron intensity for the $Re^{182} \rightarrow W^{182}$ decay with a half-life $T_{1/2} = 13$ hours is $\sim 3 \cdot 10^{-3}$ per decay. An analysis of the spectrum of this isotope indicates the presence of two β^+-decay branches with end point energies at 550 and 1740 kev and relative intensities of $0.6 \cdot 10^{-3}$ and $1.8 \cdot 10^{-3}$ positrons respectively per decay. The total transition energy was determined and found to be 2860 ± 20 kev. The positron intensity in Re^{182} ($T_{1/2}$ = 64 hour) decay is $5 \cdot 10^{-6}$ per decay. The positrons are mainly due to internal conversion with pair production during the electromagnetic transitions accompanying electron capture in Re^{182}. It is shown that the absence of β^+-decay of Re^{182m} may be due to K-forbiddenness. (auth)

17260 INTERNAL BREMSSTRAHLUNG ACCOMPANYING β-DECAY OF Ca^{45}. K. A. Korotkov, A. P. Kabachenko, Yu. A. Lysikov, and Yu. V. Dobrov (Voronezh State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 44: 45-7(Jan. 1963). (In Russian)

The internal bremsstrahlung spectrum for β-decaying Ca^{45} was measured with a single-channel scintillation spectrometer with a NaI(Tl) crystal at energies from 40 to 215 kev. The experimental spectrum is compared with that calculated from the Knipp, Uhlenbeck, and Bloch theory. It is demonstrated that at low energies the agreement with the theory is good but at energies above 130 kev the experimental values differ from those computed theoretically and exceed them by 35% at an energy of 215 kev. (auth)

17261 ELASTIC SCATTERING OF PROTONS BY Mg^{24} NUCLEI. A. K. Valter, V. E. Storizhko, and A. I. Popov (Khar'kov State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 57-62(Jan. 1963). (In Russian)

The $Mg^{24}(p,p)Mg^{24}$ elastic scattering cross section is measured for proton energies between 1,450 and 4,200 kev and angles of 90°, 125° and 141° in the c.m.s. Resonances were observed for proton energies of 1,495, 1,624, 1,670, 2,015, 2,410, 2,920, 3,140, 3,669, and 4,022 kev corresponding to Al^{25} levels with excitation energies of respectively 3.725, 3.850, 3.893, 4.224, 4.604, 5.093, 5.304, 5.812, 6.151 Mev. An analysis of the results of the measurements car-

ried out in the single-level approximation of dispersion theory shows that the broad resonance at $E_p = 3{,}140$ kev is caused by proton capture in a state with $l = 0$ and the corresponding level in Al^{25} which possesses an excitation energy of 5.404 Mev has a spin and parity $1/2^+$. The spin and parity of the 5.812 level are $3/2^+$ or $5/2^+$ and $3/2^+$ for the 6.151 Mev level. Protons are captured onto these levels in a state with $l = 2$. The characteristics of the remaining levels of Al^{25} with excitation energies below 5 Mev agree with the results of previous investigations. (auth)

17262 SEARCH FOR ANGULAR CORRELATIONS IN STARS WITH FRAGMENTS PRODUCED BY 9-Bev PROTONS. F. G. Lepekhin and M. M. Makarov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 68-70(Jan. 1963). (In Russian)

About 7,000 angles between the tracks of fragments and black tracks in disintegrations produced in the interaction between 9 Bev protons and heavy nuclei in photographic emulsions were measured. The angular distribution of the black tracks relative to the fragment tracks was found to be isotropic. The distribution of black tracks in stars with fragments and in ordinary stars was the same. (auth)

17263 POLARIZATION OF 6,5-Mev DEUTERONS ELASTICALLY SCATTERED ON Ti, Fe AND Ni. L. V. Gustova, Yu. A. Nemilov, and L. A. Pobedonostev. Zh. Eksperim. i Teor. Fiz., 44: 100-2(Jan. 1963). (In Russian)

The angular dependence of the asymmetry of deuterons scattered on Ti, Fe, and Ni is investigated. The scattering asymmetry of all three elements was found to be practically the same. It is concluded on this basis that in polarization phenomena involving 6.5-Mev deuterons, only the total number of nucleons in the nucleus are important. (auth)

17264 NEUTRON POLARIZATION IN THE $C^{12}(d,n)N^{13}$ REACTION. N. P. Babenko, B. A. Bibichev, I. O. Konstantinov, and Yu. A. Nemilov. Zh. Eksperim. i Teor. Fiz., 44: 135-6(Jan. 1963). (In Russian)

The polarization of neutrons from the reaction $C^{12}(d,n)N^{13}$ corresponding to formation of the N^{13} nucleus in the ground state is measured for $E_d = 6.5$ Mev and a reaction angle $\theta_{lab} = 40°$. The azimuthal asymmetry was measured in helium with a high pressure scintillation gas counter. The polarization is found to be $P(40°) = (-25.0 \pm 3.0)\%$. (auth)

17265 LIFETIME OF THE 0.845 LEVEL IN THE Fe^{56} NUCLEUS. R. B. Begzhanov, A. A. Islamov, D. K. Kaipov, and Yu. K. Shubnyi (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR and Inst. of Nuclear Physics, Academy of Sciences, Kazakh SSR). Zh. Eksperim. i Teor. Fiz., 44: 137-41(Jan. 1963). (In Russian)

Resonance scattering of 0.845-Mev γ quanta on Fe^{56} nuclei was studied with a gaseous Mn^{56} source in $MnCl_2$ under conditions of ring and plane geometry. The lifetime τ_γ of the first excited level of Fe^{56} determined by the self absorption method is $(9.6 \pm 1.8) \cdot 10^{-12}$ sec. This corresponds to an acceleration of the E2-transition with $E_\gamma = 0.845$ Mev by 15 times compared to the single-particle estimate made by Weisskopf. (auth)

17266 INELASTIC SCATTERING OF 6,9-Mev PROTONS BY CHROMIUM ISOTOPES. V. S. Prokopenko and N. N. Pucherov (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 44: 148-50 (Jan. 1963). (In Russian)

Angular distributions of inelastically scattered protons (initial energy 6.9 ± 0.05 Mev) due to excitation of the first levels of the $Cr^{50,52,54}$ isotopes are investigated. In the given case inelastic scattering mainly proceeds via the formation of compound nuclei, but the presence of a small deviation from symmetry with respect to 90° indicates that direct interaction is not negligible. The differences in the shapes of the angular distributions of the various isotopes may be interpreted on basis of the distorted wave theory. (auth)

17267 EXCITATION OF NUCLEI BY SLOW CHARGED PARTICLES. V. A. Dzhrbashyan (Inst. of Physics, Academy of Science, Armenian SSR). Zh. Eksperim. i Teor. Fiz., 44: 157-9(Jan. 1963). (In Russian)

The cross section for excitation of nuclei by slow charged particles is obtained by taking into account Coulomb as well as nuclear forces exhibited in resonances. It is shown that in a number of cases the interference term in the total excitation cross section is small. The results agree with the experimental data. (auth)

17268 SLOWING DOWN OF PROTONS AND μ^+ MESONS IN A METAL. B. M. Smirnov. Zh. Eksperim. i Teor. Fiz., 44: 192-7(Jan. 1963). (In Russian)

The slowing down of a heavy positive singly charged particle in a dense low temperature plasma due to elastic collisions with electrons is investigated. The method of calculating the stopping power by the Green function and diagram technique is employed for $v << v_0$ (v is the velocity of the slowed down particle and v_0 is the electron velocity on the surface of the Fermi sphere). As in the Fermi—Teller case, the change in the particle energy per unit time is proportional to v^2. The possibility of applying the dense plasma model to a real metal in calculating the stopping power is discussed. The calculated stopping power is compared with the experimental data. The μ^+-meson slowing down time in metals is estimated. (auth)

17269 SCATTERING OF SLOW ELECTRONS ON ATOMS. Yu. V. Martynenko, O. B. Firsov, and M. I. Chibisov. Zh. Eksperim. i Teor. Fiz., 44: 225-9(Jan. 1963). (In Russian)

Curves of the velocity dependence of the total effective cross section for scattering of electrons on atoms at energies $\lesssim 1$ ev are plotted on basis of polarizability of the atom and a constant which can either be determined from a point on the curve σ (E) or from the binding energy of the negative ion. The dependence of the mean electron collision frequency in the gas on temperature is derived. (auth)

17270 ON RESONANCES IN SCATTERING OF ELECTRONS ON HYDROGEN ATOMS. R. Ya. Damburg and R. K. Peterkop (Inst. of Physics, Academy of Sciences, Latvian SSR). Zh. Eksperim. i Teor. Fiz., 44: 244-6(Jan. 1963). (In Russian)

The behavior of the cross section for the elastic scattering of electrons on hydrogen atoms near the threshold of the 2s excitation level is investigated. The calculations are performed by taking into account strong coupling between the 1s and 2s levels for the incident s and p waves. Narrow resonances in the cross sections have been found below the threshold for the s wave in the singlet state and the p wave in the triplet state. (auth)

17271 LEVEL WITH SPIN I = 16 IN THE Po^{212} NUCLEUS. L. A. Sliv and Yu. I. Kharitonov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 247-8(Jan. 1963). (In Russian)

The spin of the Po^{212m} isomer level is determined. It is ascertained why no γ-transitions from this level are observed. (auth)

17272 EFFECT OF INTRACRYSTALLINE FIELDS ON THE SHAPE OF THE γ QUANTUM RESONANCE ABSORPTION SPECTRUM. G. A. Bykov (Moscow State Univ.). Zh.

Eksperim. i Teor. Fiz., 44: 249-57(Jan. 1963). (In Russian)

The problem of the effect of intracrystalline fields on the shape of the spectrum of resonance absorption of γ quanta is discussed by considering simultaneously quadrupole interaction between the nucleus and electric field of the crystal and the interaction with the radiation field. Problems involved in the dynamics of thermal motion of the particles comprising the crystal are discussed by making some highly simplifying assumptions. Nevertheless, the method employed in this investigation readily permits one to change over to any other schematization of the dynamic features of the crystal. (auth)

17273 ON THE MECHANISM OF π^--MESON CAPTURE BY LIGHT NUCLEI. I. S. Shapiro and V. M. Kolybasov. Zh. Eksperim. i Teor. Fiz., 44: 270-1(Jan. 1963). (In Russian)

Capture of stopped π^--mesons by light nuclei with formation of protons, deuterons, and tritons is considered on basis of the dispersion theory of direct nuclear reactions. It is shown that the dominant mechanism is capture of π^--mesons by α particle groups. (auth)

17274 DERIVATION OF THE PHOTOPRODUCTION AMPLITUDE FROM DISPERSION RELATIONS. N. V. Demina, V. L. Evteev, V. A. Kovalenko, L. D. Solovev, R. A. Khrenova, and Tsung-mo Chen (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 272-83(Jan. 1963). (In Russian)

An expression for the amplitude for photoproduction of pions on nucleons at low energies is derived with help of integral and differential methods on basis of one-dimensional dispersion relations. The results obtained by the two methods are compared with each other and with the experiments. The role of the unobservable region is assessed. (auth)

17275 RESIDUAL PAIR FORCES IN THE LIGHT NUCLEI O^{18} AND F^{18}. G. M. Bukat, L. A. Sliv, and G. A. Sogomonova (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 316-25(Jan. 1963). (In Russian)

The residual forces between two nucleons in light nuclei are determined. The energy levels and transition probabilities between them are calculated. The results are compared with available experimental data. (auth)

17276 EXCITATION OF COLLECTIVE STATES OF NUCLEI IN THE SCATTERING OF CHARGED PARTICLES. S. I. Drozdov. Zh. Eksperim. i Teor. Fiz., 44: 335-40(Jan. 1963). (In Russian)

Inelastic scattering of fast charged particles (protons) by translucent nuclei with concomitant excitation of the first collective levels is considered in the diffraction approximation. Comparison of the results of the calculation with the experimental data permits one to estimate the radius and nonsphericity parameter of the nucleus and also the parameter of the imaginary part of the optical potential. (auth)

17277 WEAK COUPLING MOTION OF REGGE POLES. Ya. I. Azimov, A. A. Anselm, and V. M. Shekhter (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 361-70(Jan. 1963). (In Russian)

The trajectories of Regge poles are found for scattering on a Yukawa potential (or super-position of such potentials) in the weak coupling case. The pole motion is characterized by the following qualitative features: 1) oscillation of the poles about integer negative points at energies corresponding to the left cut of the partial amplitude; 2) collision and exit of the poles into the complex plane even at a negative energy; 3) condensation of the poles near the point $l = -\frac{1}{2}$ at the threshold energy; and 4) open trajectories. Some peculiarities which arise at stronger coupling are discussed. (auth)

17278 MEASUREMENTS OF PROBABILITIES OF $\mu^- + He^3 \rightarrow He^3 + \nu$ REACTION. FINAL RESULTS. O. A. Zaimidoroga, M. M. Kulyukin, B. Pontecorvo, et al. (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 389-90(Jan. 1963). (In Russian)

The results of 200 events of $\mu^- + He^3 \rightarrow He^3 + \nu$ reaction studied in a He^3-filled diffusion chamber showed that $(\lambda_{He^3})_{exp} = (1.41 \pm 0.14) \cdot 10^3 sec^{-1}$ and is in good agreement with previous experiments studying 90 events. The universal theory with muon-electron symmetry in reaction with a nucleon is in agreement with the results obtained within 10% order of error. (R.V.J.)

17279 OPTICKÝ MODEL ATOMOVÉHO JÁDRA. (Optical Model of the Atomic Nucleus). Ladislav Gomolčák, Zdeněk Pluhař, and Ivan Úlehla. Prague, Nakladatelství Československé Akademie Věd, 1962. 132p.

In view of the absence of an all-encompassing theory, which could explain the behavior of the atomic nucleus, many attempts were made to specify models. The optical model presents special interest and is discussed in the book. The chapters include elastic scattering, inelastic scattering, nuclear reactions, the optical model in the low and high-energy ranges, the spin-orbital bond, diffraction scattering of charged particles and a detailed elementary theory of the optical model. (TTT)

17280 PHYSICS OF THE NUCLEUS. M. A. Preston. Addison-Wesley Series in Physics. Reading, Mass., Addison-Wesley Publishing Co., Inc., 1962. 670p. $15.00.

An examination of the fundamental properties (size, moments, forces, etc.) of nuclei precedes explanations of nuclear models on the basis of fundamental theory. Electromagnetic properties of nuclei are treated, as are particle radioactivity and nuclear reactions. Attempts are made at all times to correlate experimental results with the proposed concepts of nuclear structure and phenomena. (D.C.W.)

17281 NUCLEAR REACTIONS. VOLUME II. P. M. Endt and P. B. Smith, eds. From The Series in Physics. Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1962. 551p. $18.50.

Five review articles are presented; all have been abstracted separately. (T.F.H.)

17282 NANOSECOND EXPERIMENTATION WITH PULSED MACHINES. Stewart D. Bloom (Univ. of California, Livermore). p.1-41 of "Nuclear Reactions. Vol. II." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1962.

The analysis of nuclear reactions and scattering interactions by means of nsec-pulsed accelerators is reviewed. Particular attention is devoted to the use of pulsed r-f and electrostatic accelerators. Detection and measurement methods are described. A bibliography of 58 references is included. (T.F.H.)

17283 NUCLEAR FISSION. J. R. Huizenga and R. R. Vandenbosch (Argonne National Lab., Ill.). p.42-112 of "Nuclear Reactions. Vol. II." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1962.

Fission is reviewed, with emphasis on the effects of nuclear excitation energies and angular momenta in fissions involving low and medium excitation energies. Attention is

given to the competition between fission and neutron emission, angular and mass distributions of fission products, fission energetics, and isomeric ratios for shielded fission products. A bibliography of 139 references is included. (T.F.H.)

17284 THE GIANT RESONANCE OF THE NUCLEAR PHOTOEFFECT. E. G. Fuller and Evans Hayward (National Bureau of Standards, Washington, D. C.). p.113-94 of "Nuclear Reactions. Vol. II." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1962.

The oscillator strength distribution for an idealized nucleus is described, as is the interaction between the nucleus and the electromagnetic field. The nuclear dipole sum rule is presented, and the relation between the absorption and scattering cross sections is derived in the dipole approximation. Both classical and quantum systems are considered. The theoretical results are compared with experimental data. A bibliography of 161 references is given. (T.F.H.)

17285 VIBRATIONS OF SPHERICAL NUCLEI. J. M. Araújo (Univ. of Porto). p.195-247 of "Nuclear Reactions. Vol. II." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1962.

Vibrational states of spherical nuclei are investigated, within the framework of the shell (and collective) models. The vibrational modes are classified, and the harmonic approximation is presented. Quadrupole and octupole vibrations are studied. The nuclear collective parameters are calculated. A bibliography of 74 references is included. (T.F.H.)

17286 COEFFICIENTS FOR THE ANALYSIS OF ANGULAR CORRELATION MEASUREMENTS OF THE RADIATIVE DECAY OF ALIGNED NUCLEI. Philip B. Smith (Rijksuniversiteit, Utrecht). p.248-535 of "Nuclear Reactions. Vol. II." Amsterdam, North-Holland Publishing Company and New York, John Wiley & Sons, Inc., 1962.

Coefficients are tabulated that can be used in the analysis of triple-angular-correlation measurements on the two-photon decay of aligned nuclear states. The decaying state may have spin 0 to $^{11}/_{2}$. Only multipolarity of quadrupole order or lower in the photons is considered. A bibliography of 18 references is included. (T.F.H.)

17287 PERIODICHESKAYA SISTEMA IZOTOPOV. (PRILOZHENIE K STENNOI TABLITSE IZOTOPOV). (Periodic System of Isotopes. (Supplement to Isotope Table)). I. P. Selinov. Moscow, Publishing House of the Academy of Sciences, USSR, 1962. 35p.

A periodic isotope system, proton–neutron diagrams, nuclear mass difference curves for 2β-stable even isotopes, and stable nuclide diagrams showing periodic isotope regularities and properties are tabulated. The reference table includes data on transformations and lifetimes for isomers and radioactive nuclides. (R.V.J.)

17288 THE MECHANISM OF THE $C^{12}(n,\alpha)Be^{9}$ REACTION INDUCED BY 14 Mev NEUTRONS. Rahim Abid Al-Kital. Thesis, Providence, Brown Univ., 1962. 95p.

The distributions in energy and angle of α particles emitted in the $C^{12}(n,\alpha)Be^{9}$ reaction, induced by 14-Mev neutrons, were determined. Alpha particles were detected by photographic emulsions processed to give satisfactory discrimination against protons. A total of 1000 α tracks were measured, the ratio of the reaction yield to the background being about unity. The angular distributions of α particles corresponding to the 0.0 and 2.4 Mev states of Be^{9} show that the reaction proceeds by a direct mechanism. Both distributions were fitted by theoretical direct-interaction curves and spin assignments were made, representing new information in the case of the 2.4 Mev state. The ratio of reduced widths for the transitions to the ground and 2.4 Mev states was calculated and compared to the corresponding coefficients of fractional parentage. All the evidence obtained suggests that the reaction proceeds by a knockout mechanism. (Dissertation Abst., Vol. 23, No. 7)

17289 A STUDY OF HYDROGEN DIFFUSION IN METALS BY MEANS OF THE d(d,p)T REACTION. Paul Joseph Ebert. Thesis, Baton Rouge, La., Louisiana State Univ., 1962. 58p.

Gas diffusion in the metals Au, Ag, and Cu by means of the d(d,p)T reaction has been studied for deuteron energies ranging from 10 to 60 kev. The following results were obtained: targets become saturated, and the saturation progress is exponential; the saturation value is independent of beam current density; proton yield is proportional to $E^{4.5}$, where E is the deuteron energy; sputtering has no effect on saturation yields; and density distribution is proportional to x^{3}, where x is the distance in the target material. A modified diffusion theory is proposed in which the diffusion coefficient is a function of beam current density and the atomic stopping power of the metal. (Dissertation Abst., Vol. 23, No. 7).

17290 PARTICLE-GAMMA COINCIDENCE STUDIES OF ALPHA-INDUCED REACTIONS ON C^{12} AND Ne^{20}. William Whelan Eidson. Thesis, Bloomington, Ind., Indiana Univ., 1962. 161p.

The 22-Mev α-particle beam of the Indiana University cyclotron was used to bombard targets of C^{12} and Ne^{20}. Angular distributions of elastic and inelastic particle groups were measured for both nuclei. Qualitative comparison of the results both with current nuclear interaction theory and with measurements at other bombarding energies are shown. Problems concerning the production of unnatural-parity states are discussed. A search was made for a weak γ-transition between the 9.63-Mev (3^{-}) and the 4.43-Mev (2^{+}) excited states of C^{12} using the reaction $C^{12}(\alpha,\alpha'\gamma)C^{12}$ and particle–γ coincidence techniques. Weak evidence for this transition is indicated by the data, and the theoretical implications of such a transition are discussed. Angular correlations were measured between the 4.43-Mev γ-ray and the inelastic α group from the 4.43-Mev (2^{+}) level of C^{12}. The results show agreement (at small laboratory angles) with the predictions of inelastic diffraction scattering in the adiabatic approximation. Coincidence spectra of the reaction $C^{12}(\alpha,p\gamma)N^{15}$ ($Q = -4.96$ Mev) reveal the existence of a 2.3-Mev γ transition between the 7.57-Mev and the 5.28-Mev excited states of N^{15}. This transition is consistent with the shell-model predictions for the spins and parities of the two states. Coincidence spectra of the reaction $Ne^{20}(\alpha,\alpha'\gamma)Ne^{20}$ provide evidence for the existence of two new levels in Ne^{20}, and several γ transitions. A level at 7.93 Mev is thought to have spin and parity 3^{+} and to decay by cascade through the 4.97-Mev (2^{-}) level. Another level at 5.88 Mev is tentatively assigned 3^{+} and is found to decay strongly by cascade through the 4.25-Mev (4^{+}) level and weakly by cascade through the 1.63-Mev (2^{+}) level. Some verification of the recent report of a new 7.26-Mev gamma-emitting level is given. Also, the existence of the recently discovered 7.02 state is verified by the coincidence spectra. Possible interpretation of the Ne^{20} levels as rotational bands is discussed, and the difficulties of fitting the levels into rotational bands are presented. (Dissertation Abst., Vol. 23, No. 7).

17291 DOUBLE COULOMB EXCITATION WITH OXYGEN IONS. Reinhard Ulrich Graetzer. Thesis, Madison, Wis., Univ. of Wisconsin, 1962. 115p.

Total cross sections for Coulomb excitation of the first and second excited states of the ground-state rotational bands of nine even-even nuclei were measured. Oxygen ions accelerated to energies in the range 14 to 50 Mev in a Tandem Van de Graaff accelerator produced the nuclear excitations. Thin targets were prepared by evaporation of isotopically enriched rare-earth oxide powders onto thick metal target supports. The incident oxygen beam was monitored by an n-p junction detector, which counted the particles elastically scattered at 155° with respect to the incident beam. In each isotope the nuclear de-excitations from the second excited state to the first, and from the first excited state to the ground state were detected by analyzing the emitted internal conversion electrons in a wedge-shaped magnetic beta spectrometer. Cross sections for excitation of the 2^+ levels yield B(E2) values in good agreement with those obtained from lifetime measurements and from inelastic scattering of protons and deuterons. Cross sections for excitation of the 4^+ levels are compared with the multiple Coulomb excitation theory of Alder and Winther. The data are in qualitative agreement with the theory. However the observed cross-sections are systematically smaller than predicted at the lower bombarding energies. This deviation is attributed to an approximation ($\xi = 0$) in the theoretical calculation. A systematic difference between Dy^{162} and Sm^{154} data was not explained. The energies of the 4^+ levels were determined to ±2 kev. (Dissertation Abst., Vol. 23, No. 7)

17292 ELASTIC AND INELASTIC SCATTERING OF 31 Mev PROTONS FROM Pb^{208}. Gunter Gigas. Thesis, Los Angeles, Univ. of Southern California, 1962. 84p.

The angular distribution of 30.8-Mev protons from a linear proton accelerator scattered elastically from thin Pb^{208} targets was obtained at angles ranging from 6 to 156° in the center of mass system. The data were fitted by an optical model potential of Nodvik and Saxon, which was a sum of a complex central nuclear potential, a spin-orbit potential, and the Coulomb potential corresponding to a uniformly charged sphere. The angular distribution of protons resulting from the excitation of the first excited level at 2.62 Mev (3−) showed a diffraction-like pattern with approximately equally spaced maxima and minima. The cross section was strongly peaked in the forward direction. The magnitude of the cross section was reduced by a factor of 10 to 1000 from the magnitude of the elastic cross section. The elastic and inelastic distributions were in phase quadrature. A theoretical analysis of the inelastic data using the adiabatic diffraction theory of Blair for a $0 \rightarrow 3$ transition gave the proper location of the maxima and minima but not their relative magnitudes. An analysis of the data was also performed using the direct interaction theory with the optical model potential employed by Nodvik. A qualitative fit was obtained by this analysis, although it was not possible to obtain the observed strong forward peaking. (M.P.G.)

17293 NEUTRONS FROM PROTONS ON NICKEL, RHODIUM, TANTALUM, AND GOLD. Charles Howard Holbrow. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 72p.

Thin self-supporting Ni, Rh, Ta, and Au foils were bombarded with 5- to 12-Mev protons from a Tandem Van de Graaff accelerator. Neutron energy spectra arising from the (p,n) reactions were obtained by means of a pulsed-beam time-of-flight spectrometer. Spectra were taken at neutron emission angles from 0° to 140° at each bombarding energy. Below the threshold of the $Ni^{58}(p,n)$ reaction, bombardment of Ni with protons produced a neutron spectrum containing well defined structure. The peaks were attributed to the $Ni^{60}(p,n)$ reaction. Reaction energies were determined for the observed peaks. The Rh, Ta, and Au neutron spectra exhibited no structure. These continuous energy distributions were interpreted in terms of Weisskopf's statistical theory, which relates the energy distribution of the emitted particles to the level density of the residual nucleus. A nuclear temperature with an uncertainty between 7 and 15% was determined from each spectrum. These temperatures are constant for all observed neutron energies at a given bombarding energy, but increase with increasing bombarding energy. At some bombarding energies the competing (p,2n) reaction was possible. Neutrons from this reaction could in many cases be distinguished from neutrons from the (p,n) reaction by an analysis of the shape of the spectrum. No effects of direct interactions were observed. Angular distributions were isotropic and no excess of high energy particles was present in the spectra. Total (p,n) cross sections were calculated from the differential cross sections determined in this experiment. The results are consistent with values obtained by other authors. (M.P.G.)

17294 POLARIZATION PRODUCED IN THE ELASTIC SCATTERING OF 2.8 Mev NEUTRONS BY NUCLEI. Kalkunte Vedanthachar Krishma Iyengar. Thesis, Providence, Brown Univ., 1962. 109p.

Using 2.8 Mev neutrons emitted in the $D(d,n)He^3$ reaction at an angle of 49° to the deuteron beam direction as a source of polarized neutrons, the polarization produced in the elastic scattering of neutrons from C, Mg, Al, Ni, and Cu was measured at a scattering angle of 90° in the laboratory. Polarization measured for C is in agreement with that calculated from phase shift data characterizing compound-nucleus levels excited by the incident neutrons. The measured values of polarization of neutrons scattered by Mg and Al are very different and suggest that the excitation of the compound nucleus may be insufficient to justify an optical model interpretation of the data. The value of polarization obtained for Mg is in keeping with the increasing trend of polarization with scattering angle exhibited by existing data at 3.1 Mev for Mg. The value obtained for Cu is in agreement with those of previous workers at 3.1, 3.3 and 3.4 Mev. The polarizations obtained for Cu and Ni, being nearly the same, indicate that the effect of spin-spin interactions on the measured polarizations is rather small. (Dissertation Abst., Vol. 23, No. 7)

17295 HIGH ENERGY PHOTOPROTONS FROM LIGHT NUCLEI. Young Sik Kim. Thesis, Lafayette, Ind., Purdue Univ., 1962. 97p.

The angular and energy dependence of the cross sections for protons produced in Li, Be, B, and C when bombarded by 320 Mev peak energy bremsstrahlung were measured in the laboratory angular range of 20 to 96° and in the proton energy range of 140 to 190 Mev. A counter telescope using a conventional range-energy method was used to detect and identify the protons. The angular dependence was found to be nearly identical for all elements considered, and its forward asymmetry increased with proton energy. The energy spectra of the photoprotons decreased with increasing proton energy as E^{-n}, where n varied from 4 to 10 with the proton angle. A break was observed near 178 Mev in the proton energy spectra for angles larger than 86°. The cross

sections, both differential and total, were proportional to ZN/A. A Levinger-type calculation was performed. (Dissertation Abst., Vol. 23, No. 7)

17296 POLARIZATION OF PROTONS SCATTERED BY He^3. Donald G. McDonald. Thesis, Madison, Wis., Univ. of Wisconsin, 1963. 97p.

The polarization of protons elastically scattered by He^3 has been measured at six proton energies between 4 and 13 Mev over the angular range from 59 to 110°. Additional measurements have been made at 133° from 7 to 13 Mev and at 124° for 10.8 Mev. Scattering from He^4 at a laboratory angle of 45° was used to analyze the proton polarization. Most of the measurements were made with He^3 as the first target and He^4 as the second target. The first and second target pressures were as high as 20 and 6 atm respectively, giving target thicknesses up to 180 kev. The scattered proton intensity was measured simultaneously for scattering to the left and to the right. Counter telescopes, each consisting of a proportional counter and a scintillation counter coupled in coincidence, were used to detect the scattered protons. The main feature of the data is the large polarization occurring near 120° for all energies. The maximum polarization measured was $+0.65 \pm 0.06$ at 10.8 Mev and 124°. The maximum polarization measured at 4 Mev was $+0.40 \pm 0.03$ at 110°. Above 8.8 Mev, the polarization in the vicinity of 80° is negative and is as large as -0.20 ± 0.03 at 12.8 Mev and 77°. The uncertainties given include the uncertainty in the analyzing power as well as the statistical uncertainty. (M.P.G.)

17297 DECAY OF BOUND MUONS IN TITANIUM, IRON, AND LEAD. Lloyd Carlisle Nielsen. Thesis, Salt Lake City, Univ. of Utah, 1962. 102p.

The bound muon decay rate λ_d was measured for Ti, Fe, and Pb by observing the composite time distribution of decay electrons from positive and negative cosmic-ray muons. The decay electrons were detected in a 12″ deep carbon-tetrachloride Čerenkov counter which absorbed most of the electron energy. Aluminum reference targets were used to avoid the necessity for precise knowledge of the abundance ratio of positive to negative cosmic-ray muons. Particular care was taken to correct the data for contamination by muon-capture events, and for differences in decay-electron spectra. The ratio λ_d/λ_0 of bound to free decay rates was found to be 0.92 ± 0.06 for Ti, 1.05 ± 0.06 for Fe, and 0.88 ± 0.13 for Pb. The result for Pb is in agreement with recent theoretical predictions. The Ti and Fe results, taken by themselves, are in fair accord with theory. They are in good agreement, however, with the results of other measurements made at this laboratory; the combined results indicate an anomaly of about 8% near Z = 26. This discrepancy is smaller than has been previously reported. (Dissertation Abst., Vol. 23, No. 7)

17298 THE DECAY OF Sr^{85} AND Sr^{89}. Allan Richard Sattler. Thesis, University Park, Penna., Pennsylvania State Univ., 1962. 65p.

A γ ray of 0.878 Mev was found in the decay of Sr^{85} in addition to the well-known 0.514-Mev γ ray. The half lives of both γ rays were measured. The half life of the 0.878-Mev γ ray was found to be 64.9 ± 1.99 days, and the half life of the 0.514-Mev γ ray was found to be 63.9 ± 0.27 days. There is good evidence of a γ ray of 0.356 ± 0.015 Mev in coincidence with the 0.514-Mev γ ray. The 0.878-Mev γ ray was also found to be in coincidence with the characteristic x ray of Rb due to orbital electron capture. The relative intensities of the 0.878-, 0.356- and 0.514-Mev γ rays are about 1.7×10^{-4}, 0.2×10^{-4} and 1.0 respectively. A decay scheme is proposed on the basis of these results. The decay of Sr^{89} was reinvestigated in an effort to find a 10-day isomeric state previously reported. No appreciable production of such an isomer by means of neutron capture was observed. In addition a 0.913-Mev γ ray activity with a measured half life of 50.1 ± 3.4 days, attributed by some investigators to the decay of Sr^{89}, was confirmed by half life experiments. The half life of Sr^{89} was determined to be 53.6 ± 0.4 days. Sr^{89} decays to Y^{89m} to the extent of about 0.01%. Data for the radioactive decay of Se^{81} and Ba^{139} are also presented. (Dissertation Abst., Vol. 23, No. 7)

17299 THE TIME REQUIRED FOR NUCLEAR FISSION. William Earl Stein. Thesis, Albuquerque, N. Mex., Univ. of New Mexico, 1962. 137p.

A method for the measurement of the mean lifetime of compound nuclei formed in the fast-neutron-induced-fission process is proposed. The method is based on the recoil of the compound nucleus following neutron capture and the yield of secondary electrons emitted by fission fragments. The importance of the higher energy electrons, the so-called delta rays, formed in the primary ionization process is considered, in conjunction with the dependence of the electron yield of the depth beneath the surface at which a fission event takes place. On the basis of a qualitative theory, this yield is expected to increase with depth and approach asymptotically a limiting value which corresponds to the case where the fragment emerges from depths larger than the maximum range of the delta rays. Measurements of this dependence of the yield on the depth were performed with layers of uranium tetrafluoride. The general dependence predicted by the theory was observed. Experiments to determine the average distance traversed by the recoiling compound nuclei during the time interval between neutron capture and fission are described. The results show that the mean lifetimes of the compound nuclei of U^{239} and Np^{238} are, within the sensitivity of the method, consistent with zero. Upper limits of the lifetimes were obtained, however, which are considerably lower than those previously obtained. The total mean lifetimes for target nuclei of U^{238} and Np^{237} were found to be $\tau(U^{238}) < 6 \times 10^{-14}$ sec and $\tau(Np^{237}) < 4 \times 10^{-14}$ sec. The partial mean lifetimes for fission and neutron emission were determined from the relation $\Gamma = \Gamma_f + \Gamma_n$ and the previously measured ratio of the fission and neutron emission widths. The partial mean lifetimes are as follows: $\tau_f(U^{238}) < 4 \times 10^{-13}$ sec; $\tau_n(U^{238}) < 7 \times 10^{-14}$ sec; $\tau_f(Np^{237}) < 9 \times 10^{-14}$ sec; and $\tau_n(Np^{237}) < 7 \times 10^{-14}$ sec. (M.P.G.)

17300 THE SCATTERING OF PROTONS BY OXYGEN. Gerald Hardie. Thesis, Madison, Wis., Univ. of Wisconsin, 1962. 89p.

Elastic and inelastic differential cross-section measurements were made for the scattering of protons by oxygen. A differentially pumped gas target was employed. An elastic-scattering survey was conducted from 8.5 to 13.6 Mev laboratory proton energy at a center-of-mass angle of 166°52′ with 2.5 kev steps and a 2.5 kev target. Excitation curves for the elastic scattering were then taken at seven other center-of-mass angles with energy steps ranging from 5 kev to 25 kev. Detailed angular distributions of the elastic scattering were taken at laboratory proton energies from ~5 to 13 Mev. Inelastic scattering data were taken at laboratory angles of 166°00′ and 86°24′. At the 166° angle, data were taken from 10.45 to 12.98 Mev with energy steps and target thicknesses identical with the elastic scattering survey at the center-of-mass angle

of 166°52′. At 86°24′, the final group (consisting of protons when the residual nucleus was left in its first or second excited state) was studied from 8.5 to 11.3 Mev, while the second group (consisting of protons when the residual nucleus was left in its third or fourth excited state) was studied from 9.7 to 11.3 Mev. The positions and widths of several levels in F^{17} were obtained from these data. Two levels, at 12.671 and 13.215 Mev, were of particular interest because of their small total widths (<5 kev). An optical model analysis of the elastic angular distributions was performed, and the optical model parameters are presented. (M.P.G.)

17301 THEORY OF POSITRON ANNIHILATION IN SODIUM FLUORIDE. Howard Sherman Ostrowsky. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 84p.

A model of an ionic crystal of the Rocksalt structure was made by using free-ion Hartree-Fock electronic wavefunctions for the ions at each of the lattice points. This model is used to compute the wavefunction of a positron in the crystal on the assumption that the positron may be represented by a Bloch-type function not localized at any ion; positron-electron correlations are not considered. The interaction of the positron with the ions is calculated and used to determine the angular correlation of the γ rays emitted in two-photon annihilation in the crystal. Numerical computations are carried out for polycrystalline NaF, and the resulting angular correlation curves are compared with experimental results. It is found that the model is qualitatively correct, but the theoretical distribution is too wide; it is suggested that the use of free-ion electronic wavefunctions accounts for the error, and that more accurate wavefunctions for ions in a crystal of this type should be computed. It is found that the positron wavefunction is only slightly inclined toward the negative ion, so that one may roughly estimate the proportion of the annihilation which takes place with each type of ion by comparing the volumes of the ions in the crystal. (Dissertation Abst., Vol. 23, No. 7)

17302 SELECTED TOPICS IN NUCLEAR THEORY. Lectures Given at the International Summer School in the Low Tatra Mountains, August 20–September 8, 1962. F. Janouch, ed. (International Atomic Energy Agency, Vienna). Jan. 1963. 461p. (STI/PUB/67). $10.00; 210s; NF 40; DM 35 (IAEA)

The lectures were devoted exclusively to theoretical low-energy nuclear physics. They were divided roughly into three groups. Firstly, the theory of direct nuclear reactions (e.g. stripping and pick-up) was considered. They were shown to be convenient for the study of nuclear structures and to present a systematic explanation of distorted wave methods. The dispersion method was described and applied to direct nuclear reactions. The second group of lectures was concerned with models of the atomic nucleus. The present state of shell model theory was formulated and discussed in relation with other models. The closely allied theory of electromagnetic transitions in nuclei, which provides the basis of the shell model, was discussed as well as the theory of pairing correlations. Models were used to explain the characteristics of fundamental and low-lying excited levels and to calculate collective effects in nuclei. In the third group the theory of weak interactions between nucleons and leptons was discussed. Great attention was devoted to the fundamentals of muon physics. Separate abstracts have been prepared for seven lectures. (C.E.S.)

17303 DIRECT REACTIONS. N. Austern (Univ. of Pittsburgh). p.17-83 of "Selected Topics in Nuclear Theory." Vienna, International Atomic Energy Agency, 1963.

A detailed development of the standard theories of direct reactions, starting from basic principles, is given. The present status of the theories, of the techniques used for practical calculation, and of possible future developments are discussed. (C.E.S.)

17304 DISPERSION THEORY OF DIRECT NUCLEAR REACTIONS. I. S. Shapiro (Inst. of Theoretical and Experimental Physics, Moscow). p.85-155 of "Selected Topics in Nuclear Theory." Vienna, International Atomic Energy Agency, 1963.

The dispersion method was described and applied to direct nuclear reactions. This method did not make use of wave functions, but only of certain general features of reaction amplitudes such as analyticity and unitarity. In addition to providing interesting results, it permitted a better understanding of such previous results as Butler's theory of stripping. (C.E.S.)

17305 THE NUCLEAR SHELL MODEL AND ITS RELATION WITH OTHER NUCLEAR MODELS. J. P. Elliott (Univ. of Sussex, Brighton, Eng.). p.157-208 of "Selected Topics in Nuclear Theory." Vienna, International Atomic Energy Agency, 1963.

The present state of shell model theory was formulated and the connection between the shell model and other models was discussed. The lecture was not restricted to usual elements of shell model theory. The theory of multiplets and supermultiplets and a method of calculating the properties of light nuclei without using genealogical coefficients were discussed. Group theory methods were adopted for the classification of the wave functions of a many-nucleon system. Wave functions were obtained that have some of the characteristic properties of the wave functions of deformed nuclei. (C.E.S.)

17306 ELECTROMAGNETIC PROPERTIES OF ATOMIC NUCLEI. A. de-Shalit (Weizmann Inst. of Science, Rehovoth, Israel). p.209-32 of "Selected Topics in Nuclear Theory." Vienna, International Atomic Energy Agency, 1963.

The theory of electromagnetic transitions in nuclei was discussed. This study provided the main basis for the shell model, yielding important data on excited states. Magnetic and electric moments and other static properties were also discussed. The measurements of the values of the magnetic and electric moments made it possible to reach model-independent conclusions about the structure of the nucleus and the forces acting between nucleons. (C.E.S.)

17307 EFFECT OF SUPERCONDUCTING PAIRING CORRELATIONS ON NUCLEAR PROPERTIES. V. G. Soloviev (Joint Inst. for Nuclear Research, Dubna, USSR). p.233-89 of "Selected Topics in Nuclear Theory." Vienna, International Atomic Energy Agency, 1963.

The theory of pairing correlations was discussed. In the first models in which axial and non-axial nuclei were examined, deformations were considered phenomenologically as parameters of the theory. It was assumed that nucleons move in a self-consistent field with some residual interaction. This residual interaction or pairing was taken into account by a method similar to that used in the theory of superconductivity. (C.E.S.)

17308 SOME ASPECTS OF COLLECTIVE PROPERTIES OF NUCLEI. S. T. Belyaev (Inst. of Nuclear Physics, Novosibirsk, USSR). p.291-341 of "Selected Topics in Nuclear Theory." Vienna, International Atomic Energy Agency, 1963.

A superconductivity model was used to calculate collective effects in nuclei. The dependence of equilibrium conditions on the number of nucleons in the nucleus, inertia moments in deformed nuclei, and the genesis of vibrational levels in spherical nuclei were discussed. (C.E.S.)

17309 WEAK INTERACTIONS AMONGST NUCLEONS AND LEPTONS. H. A. Tolhoek (Rijksuniversiteit, Groningen, Netherlands). p.343-445 of "Selected Topics in Nuclear Theory." Vienna, International Atomic Energy Agency, 1963.

The theory of weak interactions between nucleons and leptons was discussed. The modern theory of weak interactions as newly formulated after the discovery of parity non-conservation in weak interactions was systematically explained. A detailed review of β decay was given. Great attention was devoted to the fundamentals of μ-meson physics. (C.E.S.)

Particle Accelerators

17310 (BNL-6844) MAGNET DESIGN SUGGESTIONS. Internal Report. R. A. Beth (Brookhaven National Lab., Upton, N. Y.). Mar. 12, 1963. Contract [AT(30-2)-Gen-16]. 12p.

Advantages and designs of magnets that permit either B or the magnet length to vary to obtain the desired variation of I across the aperture are examined. Reduction of the remanent field and of saturation effects and construction convenience are among the desired features noted. (D.C.W.)

17311 (CERN-62-34) ETUDE DE LA TOPOGRAPHIE DU CHAMP MAGNETIQUE DANS LES ACCELERATEURS A SECTEURS RADIAUX. (Study of the Magnetic Field Topography in Radial Sector Accelerators). B. V. Robouch (European Organization for Nuclear Research, Geneva). Nov. 7, 1962. 26p.

The magnetic field topography is considered, in cylindrical coordinates, for the case of radial sector accelerators having an azimuthal periodicity and radial field index, both of them with random values. The solutions for the case where the index is a function of the radius are defined using a recurrence formula. In the case where the index is constant, these solutions are reduced to analytical functions. A study was made on a plan model of the magnet proposed by M. Barbier for an FFAG accelerator to show that the leak field is such that its field index maintains, in the first approximation, a constant value. The reconciliation of the polar pieces defining distinct and constant index values in two different regions is then briefly considered. (J.S.R.)

17312 (IS-522) INJECTION OF ELECTRONS INTO ANNULAR MACHINES. II. DISCUSSION OF EXPERIMENTAL RESULTS. Luigi Gonella (Ames Lab., Ames, Iowa). Oct. 1962. Contract W-7405-eng-82. 82p.

The influence on the intensity of the injection-voltage rate of rise was investigated in a conventional 70-Mev electron synchrotron, injected at about 50 kv with suitable trapezoidal pulses. The intensity depends in the usual way on the various parameters, but is independent of the pulse-front slope in any condition of the machine, with the injection voltage and current varying by a factor 2. The intensity, however, is maximum at the apex of the pulse, and its variation with the pulse phase shows that matching the acceptance region cannot be critical: the capture is stopped before the time available for the injection is fully utilized. The possible saturation of the donut was tested by simultaneously injecting with two guns (that had different yields). The two injected beams never add to each other (rather one of them may kill the other) thus showing that the donut is saturated. The more efficient gun takes over the injection completely when near its optimum phase, and disturbs the injection from the other one, reducing the total yield to a very low value, when out of phase or at lower voltage. The general terms of the injection problem are analyzed for allowing a better discussion of the experiments. The discussion shows that the saturation cannot be ascribed to a space-charge limitation of the circulating current; instead, the central shift capture mechanism, as developed in the first part of the report, may explain the strong interaction between different injected beams and the dependence of the intensity on the injection current and the other parameters even while the donut is saturated. (auth)

17313 (LNF-62/95) EFFETTI DI PICCOLE ROTAZIONI DEL PIANO MEDIANO DI UN SINCROTRONE SULLE ORBITE DELLE PARTICELLE. (Effects of Slow Rotation of the Median Plane on the Particle Orbit in the Synchrotron). Note No. 165. C. Pellegrini (Italy. Comitato Nazionale per l'Energie Nucleare. Laboratori Nazionali, Frascati). Nov. 20, 1962. 15p.

The effects of a slow rotation of the median plane on the particle orbit is studied for the case in which $\nu_1 + \nu_2 \neq$ integral number and therefore, in which there is only a partial transfer of the radial and vertical unperturbed amplitudes on vertical and radial planes. A perturbation technique is used to develop the solutions in power series with respect to the rotation angles, neglecting terms of orders higher than one. The results are applied to a machine of the Adone type, and the width of the stop-band around all resonances is calculated. (J.S.R.)

17314 (MURA-654) NONLINEAR AZIMUTHAL SPACE CHARGE EFFECTS IN PARTICLE ACCELERATORS (thesis). R. A. Dory (Midwestern Universities Research Assn., Madison, Wis.). Aug. 10, 1962. Contract AT(11-1)-384. 130p.

Numerical methods were developed to simulate solution of the Vlasov equation governing the (one-dimensional) azimuthal motion of particles in circular accelerators. Unlike previous analytical solutions, these are not restricted to consideration of small perturbations. The numerical methods are used to analyze particle distributions thought to be representative of those to be found in existing accelerators. The results are found to be in accord with recent experimental data, in that the following features were found. Above transition energy, the Coulomb interaction of the particles causes formation of long-lived bound clusters of particles. Such clusters tend to follow single-particle orbits in synchrotron phase space, even when radiofrequency acceleration fields are present. When clusters interact, they can coalesce and orbit as entities about one another in the phase space. Below transition, beam bunching may occur because of nonlinear instabilities of the beam, or with a fairly simple mechanism, there develop two-stream velocity distributions that can be unstable. A symmetry principle is discussed, showing the equivalence of the "negative-mass" instability and the two-stream instability. Computer programs used in the study are included. 35 references. (auth)

17315 (ORNL-TM-524) A COLLIMATOR STUDY FOR A 20-Gev ELECTRON BEAM. C. D. Zerby and H. S. Moran (Oak Ridge National Lab., Tenn.). Mar. 25, 1963. Contract [W-7405-eng-26]. 15p.

The effectiveness of a 162.5076-cm-thick (18 radiation

lengths) aluminum collimator in a 20-Bev electron beam was studied. The collimator was cylindrical with an inside radius of 0.3175 cm. Numerical results are presented for the energy absorbed and for the energy penetrating the collimator for the case of narrow beams incident at various distances from the lip of the hole. The energy penetrating and the distribution of the energy deposited in the collimator are given for a uniform beam with an outside radius of 1.1303 cm. (auth)

17316 (SLAC-7) DESIGN AND FABRICATION OF THE ACCELERATING STRUCTURE FOR THE STANFORD TWO-MILE ACCELERATOR. A. L. Eldredge, G. A. Loew, and R. B. Neal (Stanford Univ., Calif. Stanford Linear Accelerator Center). Nov. 1962. Contract AT(04-3)-400. 82p.

The bases of choices made in designing and constructing the accelerating structure of the Stanford two-mile linear electron accelerator are discussed. The structure is to be an all-copper, cylindrical, disk-loaded waveguide, four inches in diameter and 10,000 ft long. Decisions reviewed are choice of operating frequency (2856 Mc/sec), accelerator length, number of r-f power sources and feed interval, operating mode ($2\pi/3$), constant-gradient over constant impedance structure, attenuation parameter, and wave-guide (disk-loaded). Characteristics and dimensions of many components are listed, and tables and graphs display information that determined some of the choices. Matching and tuning of an accelerator section is also discussed as are advantages of electroform and brazing for section fabrication. Cold testing to determine dimensions of constant-gradient designs is also described. (D.C.W.)

17317 (SLAC-8) TWO-MILE ACCELERATOR PROJECT. Quarterly Status Report, July 1 to September 30, 1962. (Stanford Univ., Calif. Stanford Linear Accelerator Center). Nov. 1962. Contract AT(04-3)-400. 87p.

After reconnection of the klystrons a substantial power increase was achieved with the Mark IV accelerator. Two RCA modulators with associated assemblies were also installed at the facility. A constant-gradient structure, operating in the $2\pi/3$ mode with disk thicknesses of 0.230 inch for the disk-loaded waveguide, was accepted as the final structural arrangement. Preliminary tests on accelerator sections indicate that vacuum-baking the disk-loaded waveguide will be unnecessary. Cooling tests were continued, and temperature nonuniformities were apparently results of unequal flow distribution through cooling tubes and of non-uniform contact between cooling tubes and the accelerator mockup. Tests of a waveguide vacuum valve operating as a resonant cavity indicated the structure could handle 50 Mw without breakdown. Tests with a complete valve assembly resulted in arcing, but the valve handled 40 Mw. A technique was devised for making phase measurements since the electrical phase lengths over the four parts of the accelerator sections must be within $\pm 1°$ of each other. Flange connections for waveguides were tested, particularly a modified so-called Meridian flange that offers several advantages. Focusing requirements for the two-mile accelerator were examined, and desirability of a moderate-focusing system of quadrupole multiplets was noted. Strengths and positioning of the magnets were also investigated. A prebuncher was designed, built, and installed on the Mark II accelerator. Two high-current guns for the Mark IV recently received were tested and found to deliver better than 2 amp peak beam current. The Mark IV gun modulator was modified for use with the guns. Thin valve development involved increasing the valve shafts and the disk thickness while using a different brazing technique Following modifications of the constant-gradient structure designs, structure designs for both thick and thin disks were obtained for an attenuation parameter of $\tau = 0.57$ neper. Examination of a tuned section revealed it to have a built-in stop band between 2846.9 and 2847.9 Mc/sec. Shunt impedance measurements were made for the disk-loaded waveguide structures. Experiments indicate that the group velocity variation desired could be obtained using eight, $^5/_{16}$ in. diameter holes on the periphery of the main disk aperture. Experimental and theoretical investigations of r-f transient effects in accelerator structures were performed on constant-gradient and constant-impedance structures. The results show that quicker damping of the effects is possible with the constant-gradient structure and that the resulting increase in the energy-spectrum width of the electrons should be less than $^1/_2$ percent. The previously reported waveguide pumpout operated satisfactorily at levels up to 2 Mw on the Mark IV. Beam break-up studies on the Mark III indicated that break-up can occur at relatively low currents as the electron bunches are driven into the region where longitudinal interaction with, and build-up of, the TM_{11} mode are strong. The pulsed 2856 Mc/sec signal for the main drive line was dropped in favor of either a low-frequency system without series boosters but with varactor multipliers at each sector coupling point or a 2856 Mc/sec system using cw boosters. Alteration of the 6442 triode operating conditions in the Mark IV drive system increased tube life from 50 to 1300 hrs. The complete drive system was rebuilt to eliminate undesirable ferrite components. Studies of the phase stability of varactor multipliers show that the bias should be supplied locally by bias cells and that oven control of the ambient temperature will be required. Experimental and theoretical examination of the dispersion and phase velocity of a commercial $1^5/_8$ in. coaxial transmission line showed dispersion to be negligible, and the phase velocity deviation from the velocity of light due to copper losses was also negligible. Dielectric supports and other discontinuities will reduce the phase velocity somewhat from c. An experiment to simulate the effect of adjusting only one of the 240 klystrons on the accelerator output current was made with the Mark IV. The results showed the technique impractical unless the source being phased represented at least 1% of the total energy. Experiments on the Mark III to measure the phase stability of long cable runs from accelerator section outputs to the control panel were completed and showed the hybrid system to be reasonably stable, possibly requiring once a week calibration. The phase detector unit to be used on the Mark IV for the beam-induction phasing technique was completed. One-tenth degree accuracy can be obtained with a phase-measuring set completed. Tests revealed a Sperry power limiter to have a relative phase shift that varied over a range of 40° for a 30-db relative input power range. A tri-plate variable directional coupler displayed a similar shift of 20°. Work on permanent-magnet-focused klystrons continued, and proposals by various companies to build the klystrons were considered. The second bake station was changed from diffusion and ionic pumps to diffusion pumps only. Five experimental klystrons with varying diameter were built and tested; the larger diameter klystrons require less magnetic field, but result in reduced gain. The window-life test stand was operated 917 hrs during which one window failed at 2750 hrs. Tests on the resonant cavities and the resonant ring continued. The all-metal cavity with better vacuum conditions was generally used for the cavity work. Tests indicate that the better vacuum increases breakdown resistance by a factor of 2 in power, if

initial outgassing is done slowly. Tests on alumina with voids show the disks to fail at nearly equal powers while normal material of the same composition shows a wide spread in breakdown levels. The first two modulators were brought to full output level where severe transients in the de-Q-ing circuits became uncontrollable. Several ignitrons were tested under pulsed conditions, and a survey of switching devices other than ignitrons was conducted. Engineering work done on plant engineering, microwave engineering, injector systems, accelerator structures, klystrons, windows, modulators, instrumentation and control, Mark IV operation, electronics engineering, and technical studies is briefly summarized. Research support engineering involved reviewing requirements, designing research facilities, designing magnet field analyzers, and studying heat transfer for the positron source radiator. Development of the test-stand project is also reported. Mockups, designs, and installation programs for the two-mile accelerator were prepared. The vacuum requirements were reviewed; alignment procedures were developed; support designs and special handling equipment for the machine were chosen; and cooling arrangements for the accelerator were examined. Research on providing communications between areas of the facility and the central control area is reported. Tests involved studying electromagnetic interference on transmission lines and examining a current-pulse transformer to be used as a beam-intensity monitor. Trigger systems were laid out for two sets of requirements and analyzed. Housing of the transport system and control and design of the magnet system were also investigated. Calculations were made to determine radiation intensities at various points and to determine shielding requirements. Work at Mark III confirmed previous estimates of a beam phase volume of about 10^{-8} steradian-cm^2 for the accelerator. Calculations of longitudinal shower development indicate a smaller buildup in the transition curve than was measured at Mark III. Construction work is also summarized. (D.C.W.)

17318 (SLAC-9) TRANSVERSE RADIATION SHIELDING FOR THE STANFORD TWO-MILE ACCELERATOR. H. DeStaebler, Jr. (Stanford Univ., Calif. Stanford Linear Accelerator Center). Nov. 1962. Contract AT(04-3)-400. 116p.

A third study of the shielding required for the Stanford two-mile linear accelerator deals mainly with the transverse shielding. Radiation policies and hazards are examined, and determinations are made of beam loss in the accelerator. Calculations are made for yields of nuclear particle resulting from electromagnetic cascades and comparison is made with experimental work at the Mark III accelerator. Two calculations are made of the penetration of neutrons through the shield, yielding similar results. Effects of angular spread in the nuclear cascade and effects of different geometry and different beam loss are considered. Calculations of radiation levels far from the machine are also made. Earth shielding 25-ft thick along the machine and 40-ft thick for the beam switch-yard are determined. (D.C.W.)

17319 (TID-18223) SOME DESIGN CONSIDERATIONS ON A HIGH ENERGY CYCLOTRON TO ACCELERATE NEGATIVE HYDROGEN IONS. J. Reginald Richardson (California. Univ., Los Angeles). Sept. 1962. Contract AT(11-1)-34. 26p.

Design of an accelerator to produce charged particle beams by accelerating negative hydrogen ions and stripping away the electrons is examined. Loss of negative ions by electric dissociation by electric fields is found to depend heavily on the magnitude of the hill magnetic field. Optimum magnetic field design for such an accelerator is found to require the hill field to be flat topped and to subtend a larger azimuthal angle than the valley. The valley should be deep and narrow, and the spiral angle large. Obtaining external beams with high duty factors is discussed, and designs to produce the required magnetic fields are examined. A comparison of power and material requirements for a 500 and 700 Mev accelerator is made. (D.C.W.)

17320 THE POSSIBILITY OF REDUCING THE INJECTION ENERGY IN ACCELERATORS IN THE SUPER-HIGH ENERGY RANGE. A. A. Vasil'ev. Dokl. Akad. Nauk SSSR, 148: 577-80(Jan. 21, 1963). (In Russian)

By using a magnetic system consisting of wound magnets and quadrupole lenses, particle acceleration may be achieved in the first stage, if the magnetic field induction is low and the system is strong-focusing. If the injected particle beam occupies in the corresponding phase plane an area E (emittance), fulfilling the requirement that $E < A$ (admittance), then all the injected particles will move within the vacuum chamber without touching its walls. The adiabatic attenuation of the oscillators decrease the emittance of the beam. A design is presented, showing the location of measuring electrodes and correcting electromagnets. The pairwise displayed electrodes determine the orbit of the heavy ions and the angle formed by the orbit and the longitudinal axis. The intensity-modulated beam is injected under zero initial conditions, deviating from the axis of the chamber under the influence of the perturbation forces; this deviation is first measured, then reduced by the measuring electrodes. Automatic regulation is used for accelerators with energies of 10 Bev and less. (TTT)

17321 FIRST CYCLOTRON IN YUGOSLAVIA. Savremena Teh., 253(Nov. 1962).

A cyclotron that accelerates deuterons up to an energy of 16 Mev was put into operation in October, 1962. It is the first one built in Yugoslavia and the fourth largest in Europe. The major portion of its equipment was produced in Yugoslavian workshops, and only special parts were brought from abroad. The cyclotron is designed to obtain isotopes of a number of elements; however, at present only four radioactive isotopes, Na^{22}, Zn^{65}, Fe^{55}, and As^{74}, can be produced. Pending completion of the assembly of the equipment for producing fast deuterons, only the internal deuteron beams can be used. (OTS)

17322 NONLINEAR AZIMUTHAL SPACE CHARGE EFFECTS IN PARTICLE ACCELERATORS. Robert Allan Dory. Thesis, Madison, Wis., Univ. of Wisconsin, 1962. 200p.

Numerical methods were developed to simulate solution of the Vlasov equation governing the (one-dimensional) azimuthal motion of particles in circular accelerators. Unlike previous analytical solutions, these are not restricted to consideration of small perturbations. The numerical methods are used to analyze particle distributions thought to be representative of those to be found in existing accelerators. The results are found to be in accord with recent experimental data. Above transition energy, the Coulomb interaction of the particles causes formation of long-lived bound clusters of particles. Such clusters tend to follow single-particle orbits in synchrotron phase space, even when radio-frequency acceleration fields are present. When clusters interact, they can coalesce and orbit as entities about one another in the phase space. Below transition, beam bunching may occur because of nonlinear instabilities of the beam, or with a fairly simple

mechanism, develop two-stream velocity distributions which can be unstable. A symmetry principle is discussed, showing the equivalence of the "negative-mass" instability and the two-stream instability. (Dissertation Abst., Vol. 23, No. 7)

Plasma Physics and Thermonuclear Processes

17323 (ARL-62-471) RESEARCH ON THE OSCILLATING-ELECTRON PLASMA SOURCE. Jack W. Davis, Albert W. Angelbeck, and Edward A. Pinsley (United Aircraft Corp., East Harford, Conn.). Dec. 1962. Contract AF33(616)-7448. 159p. (AD-298809)

The oscillating-electron plasma source was investigated both analytically and experimentally to determine its fundamental operating characteristics. Primary emphasis was placed on an investigation to determine the parameters that control axial potential gradients in the plasma source. It was found that potential gradients on the order of 100 v/cm can be maintained over length scales of centimeters in the essentially neutral plasma within the source. A theoretical analysis indicated that these gradients are supported by a dynamical process associated with the presence of non-thermal electron energy distributions and the tendency for the plasma to remain electrically neutral. Length scales predicted by theory were found to be in general agreement with those observed experimentally. The plasma source was found to operate in several different modes, including a fluctuating mode that appears to result from a pumping action of the source. Rotation of the plasma, apparently due to an $\vec{E}_{radial} \times \vec{B}_{axial}$ drift, was observed. Investigations were also performed to determine the limits of operation, power dissipated at electrodes and the energy distributions of ions accelerated from the source. The results of these investigations are discussed in terms of their pertinence to the development of the plasma source as a low thrust space propulsion device. 35 references. (auth)

17324 (GAMD-927) THE CALCULATION OF LINE WIDTHS. M. Baranger (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Aug. 13, 1959. Contract AF18(600)-1812. 9p.

The procedure for calculating line widths due to electrons in plasma is demonstrated using the case of the $2p \rightarrow 3d$ line in C_{IV}. Appropriate approximations permit treatment of the interaction between the perturbing electron and the ion in terms of an attractive Coulomb potential. The Coulomb corrections are noted to apparently decrease the width, not increase it. The effects of perturbing electrons are also included, and a width of 0.0185 volt is reached. Calculation of ionic widths is also discussed, and the ion width is noted to be only a fraction of the electron width. (D.C.W.)

17325 (MATT-130) A RIGOROUS CALCULATION OF THE HIGH FREQUENCY CONDUCTIVITY OF A FULLY IONIZED PLASMA. Carl Oberman, Amiram Ron, and John Dawson (Princeton Univ., N. J. Plasma Physics Lab.). July 1962. Contract AT(30-1)-1238. 32p.

A complete classical derivation of the frequency dependent conductivity is presented that properly takes into account collective dynamics. This treatment rests on the joint solution of the first two members of the BBGKY hierarchy, in the plasma limit, when both are able to change on the same time-scale. For arbitrary frequencies this leads to an integral equation for the one-particle distribution function that can be solved by conventional variational and/or numerical procedures. For frequencies high compared to the collision frequency, an explicit statement of the conductivity is possible. This high frequency limit is further examined in the limit of small electron to ion mass ratio, and these limiting results are compared with those of other authors. (auth)

17326 (MATT-133) ON THE USE OF MAGNETICALLY COMPRESSED PLASMAS IN A STELLARATOR. D. L. Dimock, J. M. Dawson, and M. A. Rothman (Princeton Univ., N. J. Plasma Physics Lab.). July 1962. Contract AF(30-1)-1238. 45p.

The feasibility of using theta pinch arrangements to heat stellarator plasmas by single shot compression is examined. Conditions inside theta pinch devices are discussed, and the requirements on magnetic field strength and currents resulting from compression are derived. A stellarator with theta pinch devices in its straight sections is deemed more suitable than a fast compression torus. Operational conditions of such a device are explored, and magnetic mirror arrangements at the ends of compression sections are found necessary. The need for permitting only a fraction of the plasma to enter the U bends is also noted. Such compression sections seem capable of filling stellarators with hot plasma. (D.C.W.)

17327 (ML-874) NONLINEAR THEORY OF PLASMA OSCILLATIONS. P. A. Sturrock (Stanford Univ., Calif. Microwave Lab.). Jan. 1962. Contract AF49(638)-415. 29p. (AFOSR-1996).

The nonlinear properties of electrostatic waves in a uniform, zero-temperature plasma free from magnetic field is investigated by two independent perturbation procedures. The first of these is the "derivative-expansion technique," applied to the Lagrangian-variable formalism. The second is a canonical-transformation procedure based on a hamiltonian description. Both procedures lead to the same formula for the dominant (four-wave) interaction process. If the spectrum is one-dimensional, the wave interaction vanishes. In general, the effect of wave interactions may be divided into "coherent" and "incoherent" contributions. The former leads to a frequency displacement that may be characterized by a dispersion relation. This is evaluated for a test wave in a thermally excited plasma and found to be of the standard form. (auth)

17328 (NP-12635) IDEAS ON THE MEASUREMENT AND SHAPING OF EMITTANCE. T. R. Walsh. Dec. 19, 1960. 9p. (HAG/INJ/23)

Ideas relevant to problems in the Nimrod injection system and concerning the fundamental principles of accelerators and beam-transport systems are discussed. An emittance measurement technique based on the elliptical beam and using defining apertures in a way closely related to emittance control is proposed. (H.G.G.)

17329 (ORNL-3392) THERMONUCLEAR DIVISION SEMIANNUAL PROGRESS REPORT FOR PERIOD ENDING OCTOBER 31, 1962. (Oak Ridge National Lab., Tenn.). Mar. 4, 1963. Contract W-7405-eng-26. 110p.

Developments in thermonuclear research are reported. Separate abstracts were prepared for nine of the ten sections. The other section is a design and engineering service report. (D.C.W.)

17330 (ORNL-3392(p.1-10)) DCX-1 PLASMA EXPERIMENTS. J. L. Dunlap, R. S. Edwards, et al. (Oak Ridge National Lab., Tenn.).

The DCX-1 experiments have again been primarily

studies of the characteristics of plasma established by low-pressure gas dissociation of the incoming H_2^+ beam. Measurements of slow plasma currents drifting to insulated end walls positioned outside the throats of the mirror coils indicate that the primary source of these currents is ionization of the background gas by fast trapped protons. Simultaneous measurements have been made of these currents, the intensity of r-f activity, the plasma potential (by the lithium beam technique), and signals to neutral-particle detectors (NPD). Coincident with bursts of r-f activity there are fluctuations in the electron current out of the mirrors, increases in plasma potential by as much as several hundred volts, and sharp increases in signals to the NPD. At the cessation of the r-f activity the current fluctuations cease, the plasma potential drops, and the NPD signals gradually recover to the steady-state values. An explanation is that the heating rate for electrons in the plasma increases with r-f activity, the plasma potential then increases in order to balance the rates of loss of slow ions and electrons, the energy-loss rate of the fast circulating protons increases, and these additional losses are reflected in a higher charge-exchange loss rate. Studies of the various field components of the r-f signals confirm the existence of charge clumps rotating with the trapped protons and have also shown, at low pressures, the existence of a repetitive short-burst activity involving purely longitudinal currents or electric fields. Injecting an electron beam into the plasma along field lines causes marked changes in the r-f signals and in the energy distributions of the charge-exchange neutrals. The injection of 400-kev H_2^+ has been coupled with electron-cyclotron heating in the plasma region. Although there is evidence for electron heating, the dissociation of the molecular-ion beam was not enhanced by the modest power levels employed (about 5 w). (auth)

17331 (ORNL-3392(p.11-27)) DCX-2. P. R. Bell, J. S. Culver, et al. (Oak Ridge National Lab., Tenn.).

Experiments with 600-kev H_2^+ injection into DCX-2 with beam current up to 50 ma have yielded plasmas with a nonuniform axial distribution. Densities up to 10^8 fast ions/cm^3 are obtained in the slight field dip at the end of the flat field region, whereas densities of 10^6 to 10^7 are found in the uniform field. The trapped plasma decays with approximately the expected mean life for charge exchange after the injected beam is turned off. The dissociation neutrals show that protons are being produced at the expected rate, but they are disappearing 10 to 50 times more rapidly than expected. The trapped protons may be removed by precession into the injector due to electric fields; by anomalously rapid radial diffusion followed by normal precession into the injector; by unexpectedly high energy-loss rates, resulting in much more rapid charge-exchange rates; or by other unknown processes. Some evidence for anomalous radial diffusion is given by probe measurements showing fast ions at a radius greater than expected. The rather intense, predominantly H^+-ion-cyclotron radiation has been studied, and it exhibits rapid fluctuation of harmonic content and, under some conditions, a random phase relation between probes spaced axially or azimuthally. Evidence for some plasma pumping is found, and probe studies of the cold plasma ejected through the mirrors show only a moderate (<1 kv) plasma potential and an absence of any appreciable escape of energetic ions axially. The measurements are complicated by clear evidence that a relatively small probe at the mirror maximum affects the electron population seen on a probe close to the flat field region, but along the same magnetic field lines. Further studies of the plasma are under way, and attempts will be made to reduce the instability by electron injection, alteration of the radial electric field, and localized and increased dissociation of molecular ions. (auth)

17332 (ORNL-3392(p.28-46)) PLASMA PHYSICS. W. B. Ard, M. C. Becker, et al. (Oak Ridge National Lab., Tenn.).

The plasma produced by electron-cyclotron resonance in a mirror magnetic field has exhibited interesting new phenomena with a scaleup in applied microwave power above 1 kw. Neutron emission from the deuterium-fed plasma has been observed and validated by foil activation measurements. Further studies have shown that the neutron production rate, the 8-mm microwave noise amplitude, and the axial diamagnetic field increase roughly as the square of the applied microwave power. The maximum microwave noise amplitude and the maximum neutron emission rate are correlated with the microwave heating zones being located near the mirror throats. The maximum neutron emission rate is also correlated with quiescent plasma operation. These neutrons appear to be largely due to the electrodissociation of deuterium by plasma electrons with energies greater than 2.22 Mev. A theoretical analysis of a plasma which considers only charge-exchange losses, scattering losses, and ion cooling to the temperature of the electron sink has been made. For deuterium plasma whose charge-exchange cross section approaches zero at finite energy, there is shown to be an optimum ion energy near this value for long containment. The plasma decay after source removal has been time-analyzed theoretically, and a decay constant has been predicted. Some experimental observations of a random plasma confined between magnetic mirrors are recorded which seem to confirm the theory. A shift in the resonant frequency of a microwave cavity enclosing the plasma is shown to be a good diagnostic tool for the determination of the plasma decay constant. An army surplus Snooperscope has been converted to a stroboscopic device for observing periodic fluctuations in plasma light intensity. (auth)

17333 (ORNL-3392(p.47-8)) VACUUM ARC RESEARCH. J. R. McNally, Jr., and M. R. Skidmore (Oak Ridge National Lab., Tenn.).

An analogy to possible fuel-feed heating mechanisms is suggested by continuing studies on the magnetically confined carbon arc. "Fuel" ion temperatures up to 2.5×10^{6}°K are reported; the evidence suggests rapid internal electric-field heating transverse to the magnetic flux lines. (auth)

17334 (ORNL-3392(p.49-55)) ION PRODUCTION, ACCELERATION, AND INJECTION. R. C. Davis, R. R. Hall, et al. (Oak Ridge National Lab., Tenn.).

The DCX-2 injection system was operated at total ion currents up to 150 ma while injecting into the plasma region. The maximum H_2^+ ion current injected into the machine does not increase significantly, however, as the total current is increased above 100 ma. The maximum H_2^+ beam injected was 50 ma with a total current of 150 ma. The original accelerator tube developed for high-current injection was replaced with one that has epoxy skirts cast around the porcelain insulators. This tube has operated on DCX-2 at greater than 600 kv, but not reliably above 570 kv. Modifications are being tested which should allow satisfactory operation at 600 kv. An FM link was developed to transmit current information with time resolution of about 10 μsec from the 600-kv level to ground. The equipment for doing beam emittance work was installed at the

High-Intensity-Beam Facility, but time has not permitted its use. The 100-kev neutralized-beam accelerator was operated in the 10- to 20-kev range with hydrogen, helium, nitrogen, and argon. The hydrogen results are unique in that the injected electron beam may be made to increase, by a factor of 4 to 5, the power delivered to target over that obtained without electron injection. The current equivalent to the measured power on the target is about 18 to 20 ma. The beam is believed to be neutralized because the power on target is independent of whether the target is at ground potential or electrically insulated. In the latter case, the target floats at ground potential. No significant power increase due to electron injection was observed with the helium, nitrogen, and argon beams. (auth)

17335 (ORNL-3392(p.56-65)) THEORY AND COMPUTATION. E. G. Harris, T. K. Fowler, et al. (Oak Ridge National Lab., Tenn.).

The effect of a distribution of ion cyclotron frequencies on the cyclotron resonance instability is investigated. The dependence of the cyclotron frequency on position in the machine is neglected. A distribution in ion cyclotron frequencies has the same effect qualitatively as a thermal distribution of ion velocities; both tend to stabilize the plasma. If the spread in frequencies is sufficiently great, then the plasma is stable for sufficiently high particle densities. Stability in the nonlinear case is found sometimes to be a consequence of stability in the linear case. The use of the Lyapunov functions in connection with moment equations and the linearized Vlasov equations suggest a rather general treatment of the problem of stability without the necessity of detailed solution of the equations. Two topics that are briefly treated are the stability of inhomogeneous collisionless plasma and correlation damping. The cross section for the Coulomb dissociation of deuterons by electrons has been calculated from the threshold at 2.2 Mev to 6 Mev in the electron energy. A new code, MADCAP, has been written for the calculation and plotting of single-particle trajectories in electromagnetic fields. By computing the magnetic field by Taylor's series expansion from a stored table of field components and derivatives, a time factor of ~6.5 is gained over previous codes. Plots of pertinent physical information are also prepared by the code. Two codes, one for energy-spectrum analysis and one for containment zones, have been written to facilitate studies of data taken in DCX-1. The study of the relationship between molecular-ion injection current and trapped-ion density has been continued, treating molecular-ion energy, path length, and an arbitrary enhancement of energy transfer rates as parameters. (auth)

17336 (ORNL-3392(p.66-85)) MAGNETICS AND SUPERCONDUCTIVITY. C. E. Parker, R. L. Brown, et al. (Oak Ridge National Lab., Tenn.).

Two new codes for calculating magnetic properties of current systems are discussed. The first is based on zonal harmonics, and the second is based on Gaussian integration of elliptic integrals. Three new magnet coils representing advances in d-c magnet technology are described: a magnet designed to produce 118 kilogauss (2-in. bore), one coil of an 80-kilogauss pair (7-in. bore), and a 6-kilogauss solenoid wound from flexible cable. The 2-in. magnet has been successfully tested at 104 kilogauss, and during safety tests the other two coils performed as expected at their design current. An efficient cryostat test cell has been designed and tested. Temperature stability of ±0.01°K throughout the range 1.5 to 20°K facili'ates a variety of experiments. More advanced designs are also discussed. The introduction of large currents into a cryogenic apparatus creates a heat leak problem. Attempts to minimize the heat leak of nitrogen precooling and gas cooling are described. A 50% reduction in vaporized helium was found possible. The performance of superconducting coils is so complex that it is not yet well understood. One initial step toward reaching a better understanding is a study of the proximity effect displayed by two parallel, infinitely long superconducting wires. For ideal superconductors the magnetic field produced by currents flowing through the wires is calculated on the assumption that the surface layer of each superconductor is superconducting. Preliminary experiments were made to find the critical current strength and to determine the resistance performance in intermediate state. A more complete experimental and theoretical analysis is under way. (auth)

17337 (ORNL-3392(p.86-8)) VACUUM SYSTEMS, TECHNIQUES, AND MATERIALS STUDIES. R. E. Clausing, J. D. Redman, and R. A. Strehlow (Oak Ridge National Lab., Tenn.).

Vacuum studies have provided data on the sticking factors of various gases in baked systems. Nude-gage calibrations have shown that in systems pumped by oil diffusion pumps, significant discrepancies in pressure readings may exist. Diffusion-pump studies have included development work on a surface-boiling pump in which oil level appears to play a significant role on the fluid throughput of the pump and on relative pumping speeds for H_2 with respect to air. (auth)

17338 (ORNL-3392(p.89-93)) SPECULATION ON THE ATTAINMENT OF A HIGH DENSITY AND A LARGE CIRCULATING CURRENT OF VERY HOT PROTONS IN A MAGNETIC-MIRROR DEVICE. J. R. McNally, Jr. (Oak Ridge National Lab., Tenn.).

Speculation is made on the attainment of a high density ($\gtrsim 10^{12}$ protons/cm^3) and large circulating current of very hot protons in a magnetic-mirror device. Lorentz trapping and exponential growth resulting from injection of 6-Mev H_2^+ into a 30,000-gauss field suggest the possibility of producing a natural plasma configuration in which a closed toroidal magnetic bottle may be developed by the applied mirror magnetic field and the self-field of the azimuthal proton current. (auth)

17339 (R63SD16) THE TRANSIENT INTERACTION OF A TRANSVERSE MAGNETIC FIELD WITH FLUID IN COUETTE FLOW. F. H. Shair (General Electric Co. Missile and Space Div., Valley Forge Space Technology Center, King of Prussia, Penna.). Feb. 1963. Contract AF49(638)-1092. 57p.

Solutions are given to MHD Couette flow systems with increasing complexity. The problem of Couette flow with an oscillating transverse magnetic field is solved. The solution is obtained by means of a transformation which demonstrates the similarity between a set of transient MHD systems and a set of transient heat conduction systems. Under various conditions, the solution of the oscillating MHD system reduces to various solutions of simpler systems. Although the Couette flow system was chosen for simplicity, the results of this analysis are useful for the determination of: the start-up time interval for both MHD-AC and MHD-DC systems and the steady state distortion in the alternating current output for MHD-AC systems. (auth)

17340 (TID-18115) BROWNIAN MOTION AND "RESONANCE DIFFUSION" IN A MAGNETIC FIELD. Behram

Kursunoglu (Miami, Fla. Univ., Coral Gables and Oak Ridge National Lab., Tenn.). Plasma Physics Bulletin, Vol. 1, 1963. [1962]. Contracts AT(40-1)-2761 and AF19(604)-8082. 20p.

Diffusion of electrons and ions in a plasma across a magnetic field with the interplay of an unisotropic dynamical friction is formulated in terms of the methods of Brownian motion. For a special symmetry of the dynamical friction matrix it is found that for Larmour periods of the order of the relaxation time across the magnetic field the diffusion takes place as an ordinary Brownian motion uninhibited by the external magnetic field. Resonance diffusion is also examined. (auth)

17341 (TID-18225) CHERENKOV-LIKE RADIATION BY PLASMA OSCILLATIONS. G. Schmidt and G. Halpern (Stevens Inst. of Tech., Hoboken, N. J.). [1961]. Contract [AT(30-1)-2813]. 5p.

Emission of radiation from moving charged particle bunches analogous to Cherenkov radiation from single particles is expected if the phase velocity of longitudinal plasma oscillations in an infinite plasma exceeds the speed of light in vacuum. Radiation fields from an infinite linear current source and from a finite cylinder with a uniform oscillating current density are derived. Also an expression for power radiated per unit length from the infinite source is given. Evidence for the existence of phase velocities >c in finite plasmas is presented and found credible in terms of the Cherenkov radiation fields calculated. Radiation from a plasma slab or cylinder in a strong magnetic field is also discussed. (D.C.W.)

17342 (UCRL-7115) INVERTED CASCADES IN NEUTRAL INJECTION SYSTEMS. John R. Hiskes (California. Univ., Livermore. Lawrence Radiation Lab.). Nov. 6, 1962. Contract W-7405-eng-48. 15p.

A process is described whereby the successive collisional excitation of the excited state distribution of an energetic neutral beam can result in the almost complete Lorentz ionization of the initial excited state population. The development of the cascade may permit an exponential growth of the ion density in contemporary neutral injection experiments for base pressures an order of magnitude higher than required for exponentiation by collisional ionization. (auth)

17343 HEURISTIC APPROXIMATIONS TO THE EQUATION OF STATE AND ENERGY FUNCTION OF A PERFECT FERMI-DIRAC GAS FOR ARBITRARY TEMPERATURE AND DEGENERACY. H. A. Buchdahl (Univ. of Tasmania, Hobart). Ann. Physik (7), 10: 31-16(1962). (In English)

The exact equation of state and total energy function of a perfect Fermi-Dirac gas for arbitrary degree of degeneracy, and when relativistic effects are fully taken into account, can be exhibited only in a rather unsurveyable parametric form. It is therefore desirable to have approximations available which provide the pressure P and the total energy density u explicitly as functions of the temperature T and the particle density n. Such "heuristic" approximations are constructed in this paper, that is to say, approximations which tend asymptotically to the correct functions in certain extreme regions (e.g., that of complete degeneracy and either very small or very large density), and which numerically reproduce them sufficiently closely throughout the entire ranges of values which the variables T and n can take. Numerical investigations of the approximations considered here suggest that they should be sufficiently good to be useful in some astrophysical problems. (auth)

17344 THE THEORY OF LONGITUDINAL PLASMA OSCILLATIONS IN THE FORMATION OF A RUNAWAY ELECTRON STREAM. H. M. Skarsgard (Univ. of Saskatchewan, Can.). Can. J. Phys., 41: 450-68(Mar. 1963).

The theory of longitudinal oscillations accompanying the acceleration of electrons in a neutral plasma is investigated. Particular reference is made to an experiment with a plasma betatron supplemented by a strong longitudinal magnetic field. Various stability criteria are derived which show that for runaway electron streams of interestingly large intensity an interval of instability is always encountered during the initial acceleration. Calculations of the fluctuation energy built up during this interval were made in order to determine the conditions for which the fluctuation energy is not expected to overtake the drift energy. For a two-stream plasma consisting of the runaway electron stream and a slow ion stream, it is found that even for relatively small accelerating electric fields rather intense runaway streams can escape disruption due to the instability (e.g., for $E \approx 2000$ volt m^{-1} runaway beam densities corresponding to currents of about 4000 amp, at relativistic energies, may be expected to escape disruption). However, if relatively few slow electrons are present in the beam the critical runaway beam density is drastically reduced. The effect of finite rise-time for the accelerating electric field is considered. (auth)

17345 EXPERIMENTS WITH MOVING MAGNETIZED PLASMA. P. R. Smy and A. Offenberger (Univ. of British Columbia, Vancouver). Can. J. Phys., 41: 469-77(Mar. 1963).

Results of various experiments with moving magnetized plasma produced in a shock tube are presented. It is found that both incident and reflected shock speeds are independent of the applied field strength up to the maximum of 10^4 gauss. Measurements of the momentum transfer from the magnetized plasma to an essentially diamagnetic ring surrounding the shock tube were accomplished by mechanical and electrical means; the mechanical measurements show good agreement with theory. (auth)

17346 TEST OF THE PHYSICAL INTERPRETATION OF AN ENERGY CONVERSION PHENOMENON. Jean Debiesse, Siegfried Klein, and Joseph Taillet. Compt. Rend., 255: 3144-6(Dec. 5, 1962). (In French)

The possibility of collecting the electrical power from electrodes plunged in a gas at pressure close to atmospheric pressure, propelled by a rotation movement or to great pressure variations, and exposed to x irradiation was recently shown experimentally (Compt. Rend., 254: 4151(1962)). The phenomenon is particularly sharp with argon. A possible explanation for this energy conversion is proposed. (tr-auth)

17347 ELECTRON DISTRIBUTION FUNCTION OF AN ANISOTROPIC AND INHOMOGENEOUS PLASMA IN THE PRESENCE OF A MODULATED ELECTRIC FIELD. Diptendu Basu, Raymond Jancel, and Théo Kahan (Institut Henri Poincare, Paris). Compt. Rend., 256: 84-6(Jan. 2, 1963). (In French)

A method is reported for the resolution of the Boltzmann equation for the electron distribution function of an anisotropic and inhomogeneous Lorentz plasma exposed to the action of a modulated electric field. (tr-auth)

17348 THE STATISTICAL THEORY OF A UNIFORM ISOTROPIC TURBULENCE IN A RELATIVISTIC PLASMA. Yu. L. Klimontovich (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 147: 1063-6(Dec. 11, 1962). (In Russian)

A function of the density in phase space $[Na(q,p,+)]$, and the strengths of the microscopic fields $E^{(m)}$ and $N^{(m)}$ can be

used to characterize the microscopic state of a relativistic plasma. The statistical properties of the plasma are determined by the first and second moments of the random functions of Na, $E^{(m)}$, and $H^{(m)}$, especially if the parameter $\epsilon = 1/nr^3d \ll 1$. In a spacially uniform plasma, $\overline{Na} = n_a f_a$, $\overline{E}^{(m)} = 0$, $\overline{H}^{(m)} = 0$, and the second moments depend only on the coordinate difference (q-q'). Here $f_a = f_a(p,t)$ is the first distribution function. Equations are written for f_a, $\delta N_a = \overline{N}_a - N_a$, $\delta E = E^{(m)} - \overline{E}^{(m)}$, and $\delta H = H^{(m)} - \overline{H}^{(m)}$. In a uniform plasma, the transverse ($\perp$) and longitudinal ($\parallel$) components of the vector δE are not correlated with each other. A closed set of equations are derived for the functions f_a, $(\delta E^{(\parallel)}\delta E^{(\parallel)})_k^{rad.}$, and $(\delta E^{(\perp)}\delta E^{(\perp)})_k^{rad.}$. Expressions are given for the coefficients in these equations which describe the "collision" of charged particles in the plasma. An expression is given for the space-time spectral distribution. (TTT)

17349 THE STABILITY OF A CYLINDRICAL PLASMA JET IN A MAGNETIC FIELD. L. S. Solov'ev. Dokl. Akad. Nauk SSSR, 147: 1071-4(Dec. 11, 1962). (In Russian)

A set of magnetohydrodynamic equations for stationary spiral flow of an ideally conducting, incompressible liquid in a magnetic field is presented and discussed. The equation $\xi(r,\theta) = \text{const}$ describes a family of magnetic surfaces possessing spiral symmetry. A choice of coordinates was made to describe an unperturbed state having cylindrical magnetic surfaces. In deriving the wave equation, use was made of the invariance of the functions on ξ with respect to deformation of the magnetic surface, that is, on going from an unperturbed to a perturbed state. This wave equation is, in general, non-linear. Only the linearized equations, and the boundary conditions for the waves in a plasma jet are presented. A solution is pointed out for the case of plasma cylinder rotating as a unit ($\nu_\phi = \text{const}$) having a uniform, longitudinal current ($h_\phi = \text{const}$), and a uniform, longitudinal magnetic field ($H_z = \text{const}$). A surface instability occurs when the spiral perturbation of the plasma surface is directed along the force lines of the magnetic field. This instability is associated only with the surface of the plasma cylinder, and is independent of the distribution of the internal magnetic field. (TTT).

17350 DENSITY FLUCTUATIONS IN A NONEQUILIBRIUM PLASMA. E. E. Salpeter (Cornell Univ., Ithaca, N. Y.). J. Geophys. Res., 68: 1321-33(Mar. 1, 1963).

A dilute ionized gas is considered, for which electron-ion collisions can be neglected and that deviates from thermal equilibrium by having an ion temperature T_i different from the electron temperature T_e. These conditions apply to the ionosphere in the F layer and above. Methods are reviewed for treating statistical mechanics at thermal equilibrium and the Boltzmann equation for general problems. The electron-electron, electron-ion, and ion-ion pair correlation functions are derived for general T_e/T_i and an arbitrary time-independent magnetic field. The total cross section for scattering of an electromagnetic wave from such a gas is derived for general T_e/T_i. The results are shown to agree with the integral of the theoretical frequency spectrum derived previously by a number of authors. For long wave length and $T_i/T_e \ll 1$ the cross section is proportional to T_i/T_e. The sources of error for an incorrect result stated by Renau are explained. (auth)

17351 TRANSPORT COEFFICIENTS OF A MAGNETOPLASMA IN AN ALTERNATING ELECTRIC FIELD. Shobu Kaneko (Tokyo Univ.). J. Phys. Soc. Japan, 18: 139-41(Jan. 1963). (In English)

Transport coefficients of a magnetoplasma in the simultaneous presence of an alternating electric field and a temperature gradient are investigated. They are shown to be expressed in terms of the transport coefficients in a stationary electric field and to satisfy symmetry relations between the electron cyclotron frequency and the frequency of the electric field. As an example, these results are applied to the electrical conductivity and the transport coefficient between the heat flow and the electric field. (auth)

17352 EXPERIMENTAL STUDY ON THE HELICAL INSTABILITY IN THE POSITIVE COLUMN IN A MAGNETIC FIELD. Susumu Shimamoto, Shingo Imazu, and Yoshiei Nakano (Tokyo Inst. of Tech.). J. Phys. Soc. Japan, 18: 149-50(Jan. 1963). (In English)

The properties of the helical instability in the positive column of a d-c discharge in a magnetic field were measured with Langmuir probes in helium gas. The probe method was made possible by obtaining quiescent positive columns. The frequency and the wave length were in good agreement with theoretical predictions and experimental results measured with photomultipliers. (C.E.S.)

17353 THERMONUCLEAR ENERGY — A NEW SOURCE OF ENERGY FOR THE FUTURE. Kung Yu. K'o Hsueh Ta Chung, No. 11, 345-6; 349(1961).

The use of thermonuclear reactions, such as the fusion of deuterium or tritium, as a source of energy is discussed. Problems that must be solved are mentioned. (P.C.H.)

17354 COAXIAL PLASMA INJECTOR. Stefan Chwaszczewski. Nukleonika, 7: 539-46(1962). (In Russian)

The construction and first measurements of a coaxial plasma injector are described. The injector consists of an outer hollow cylinder with a conducting rod at its center. The rod is insulated from the outer cylinder and is connected to a condenser bank and switching and charging circuitry. The coaxial system opens, at one end, to a vacuum system and a set of three plasma probes. Hydrogen gas is admitted between the cylinder and rod. When the charged condenser bank is switched on, a disk of plasma is created at some point along the rod. This propagates in both directions along the rod. The plasma injection characteristics are studied in the evacuated region at the end of the coaxial source by the probes whose outputs are recorded as a function of time. These are compared with an oscillogram of the current across the coaxial gap, yielding the velocity, acceleration, and other parameters of the injected plasma as a function of time after injection. This type of measurement works very well for fast plasma propagation times. The results of the measurements are presented. (TTT)

17355 SCHLIEREN PHOTOGRAPHY OF AN ORTHOGONAL PINCH. U. Ascoli-Bartoli and S. Martellucci (EURATOM-CNEN, Rome). Nuovo Cimento (10), 27: 457-96(Jan. 16, 1963). (In English)

The possibility of utilizing the Schlieren method for detecting and eventually for measuring the gradients of density of a plasma produced in a pulsed discharge is studied. The dependence on parameters and the practical realizability of the apparatus are discussed. The application of the method to the study of an orthogonal pinch is described. (auth)

17356 INSTABILITY OF A PARTIALLY IONIZED PLASMA IN CROSSED ELECTRIC AND MAGNETIC FIELDS. Albert Simon (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 6: 382-8(Mar. 1963). (SA-3604)

A weakly ionized plasma in a uniform magnetic field is considered. Application of a potential across the magnetic field results in a steady current flow, owing to the finite

conductivity. It is shown that this steady state is unstable if the plasma density is nonuniform in the direction of the applied electric field and if the applied potential is large enough. It is necessary that the sign of the product of the electric field and the density gradient be positive. (auth)

17357 DISPERSION FUNCTION FOR A PLASMA WITH A CAUCHY EQUILIBRIUM DISTRIBUTION. H. B. Liemohn (Boeing Scientific Research Labs., Seattle) and F. L. Scarf. Phys. Fluids, 6: 388-93(Mar. 1963).

The dispersive properties of a plasma with a generalized Cauchy equilibrium velocity distribution of the form $(v^2 + a^2)^{-s}$ are derived for certain modes of propagation. The plasma dispersion function is found in a simple algebraic form that makes the solution of the dispersion equations readily accessible. A quartic dispersion relation that is obtained for right-hand circularly polarized electromagnetic waves propagating along a uniform static magnetic field is solved for all frequencies including cyclotron resonance. The complex index of refraction for this mode is plotted for several values of the temperature and the plasma cyclotron frequency ratio. In general, thermal effects reduce the infinite discontinuity in phase at the cyclotron resonance to a finite value and cause thermal damping of the propagating wave below resonance. The results are compared with previous numerical analyses using the Maxwell distribution. (auth)

17358 EFFECT OF ION CORRELATIONS ON HIGH-FREQUENCY PLASMA CONDUCTIVITY. John Dawson and Carl Oberman (Princeton Univ., N. J.). Phys. Fluids, 6: 394-7(Mar. 1963).

In an earlier work the a-c conductivity of a plasma was investigated by means of an elementary model. The validity of this model was borne out by a rigorous treatment of plasma at thermal equilibrium. The elementary model is now extended to include the effects of ion correlations for arbitrary fixed ion distributions. For thermal equilibrium correlations it is found that the ion shielding reduces the maximum effective impact parameter by the factor $(1 + Z)^{\frac{1}{2}}$ (i.e., both ions and electrons contribute to the shielding) for frequencies low compared to the plasma frequency ω_p. For frequencies high compared to ω_p, the previous results remain. The resistance due to the excitation of longitudinal waves at frequencies just in excess of ω_p is reduced by the factor $(1 + Z)^{-1}$. However, if large-amplitude (nonthermal) ion fluctuations are present, the longitudinal wave contribution to the resistance may be greatly enhanced. (auth)

17359 NUMERICAL EXPERIMENTS WITH A PLASMA MODEL. O. C. Eldridge and M. Feix (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 6: 398-406(Mar. 1963). (SA-3430)

The exact motion of a one-dimensional system interacting through the electrostatic field is followed using a fast computer. The properties of the model are discussed and related to the three-dimensional plasma. New results are presented for the drag and diffusion of test particles and the space and time correlations of the charge density. These experiments agree with the conventional theory. In an appendix is derived the kinetic equation for this model to first order in the small parameter, the reciprocal of the number of particles in the Debye length. To first order a velocity distribution is constant in time. (auth)

17360 BEHAVIOR OF A PLASMA, PRODUCED BY A BUTTON-TYPE SOURCE, IN PRESENCE OF A MAGNETIC FIELD. M. Alidieres, R. Aymar, Ph. Jourdan, F. Koechlin, and A. Samain (Euratom-CEA, Paris). Phys. Fluids, 6: 407-17(Mar. 1963).

In a plasma produced by a hydrogen-loaded titanium electrode gun, the pertinent physical quantities — mass, velocity, angular divergence, ion species, and resistivity — are experimentally determined. This plasma is injected along the axis of the magnetic configuration of a loop coil, and also transverse to the field of two parallel coils. The observed motion of the plasma is described, and explained mainly by macroscopic interaction of the plasma with the field. (auth)

17361 OBSERVATION OF PLASMA ROTATION PRODUCED BY AN ELECTRODELESS PLASMA GUN. Daniel R. Wells (Princeton Univ., N. J. and Stevens Inst. of Tech., Hoboken, N. J.) and George Schmidt. Phys. Fluids, 6: 418-21(Mar. 1963).

Rotation of plasma produced by a conical θ-pinch coil fired down the axis of a longitudinal magnetic field is investigated. It is found that rotation is observed whenever the magnetic field in the θ-pinch coil is permitted to change sign and is absent whenever it is crowbarred. Rotational velocity agrees with the measured E_r/B_z values within experimental error. Possible explanations of the origin of the rotation are discussed. (auth)

17362 LOW-FREQUENCY OSCILLATIONS IN A POTASSIUM PLASMA. N. D'Angelo and R. W. Motley (Princeton Univ., N. J.). Phys. Fluids, 6: 422-5(Mar. 1963). (MATT-141)

Low-frequency oscillations (10–30 kc/sec) were observed in thermal potassium plasmas, produced by surface ionization of potassium atoms on a hot tungsten plate. The oscillations are associated with the presence of an ion sheath near the tungsten plate and seem to be reasonably well described on the basis of a simple picture of ion waves propagating across the magnetic lines of force, in the presence of a density gradient. (auth)

17363 COUPLING OF MAGNETOHYDRODYNAMIC TO ELECTROMAGNETIC WAVES AT A PLASMA DISCONTINUITY. II. THE NONPROPAGATING FIELD. Sheldon L. Kahalas (Mt. Auburn Research Assn., Inc., Cambridge, Mass.). Phys. Fluids, 6: 438-46(Mar. 1963).

The coupling of magnetohydrodynamic to electromagnetic waves at a plasma–vacuum boundary is considered for the case in which the angle of incidence of incidence of the magnetohydrodynamic wave falls outside the cone for radiation. When this occurs, the electric and magnetic fields transmitted into the vacuum region decay exponentially in space in the direction of the normal to the boundary. The phase velocity in a direction parallel to the plane boundary has a value between the Alfvén velocity and the velocity of light, depending upon the angle of incidence of the magnetohydrodynamic wave. The magnitude, frequency, and angular dependence of the transmitted electric and magnetic fields are explored. In one situation a phenomenon called a transmission resonance is found to occur; i.e., the ratio of the transmitted to the incidence electric field becomes very large over a restricted range of angles of incidence. (auth)

17364 MODEL OF AN ELECTRICAL DISCHARGE IN A NEUTRAL GAS. Richard E. Aamodt (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Fluids, 6: 446-9(Mar. 1963).

An equation determining Townsend's first ionization coefficient is derived for a model of a gas consisting of infinitely massive molecules which have total cross sections varying inversely as the electron energy. The equation is solved, and the results plotted as a function of the ratio of the applied electric field strength to the gas pressure when the parameters are chosen characteristic of the hydrogen molecule. (auth)

17365 OPTIMUM ENERGY FOR PLASMA CONFINEMENT. I. Alexeff, R. V. Neidigh, and E. D. Shipley (Oak Ridge National Lab., Tenn.). Phys. Fluids, 6: 450-1(Mar. 1963).

It was shown that loss rates from ion-neutral multiple scattering and for charge exchange can be made quite low for deuterons in deuterium by choosing the ion energy properly. The calculated ion loss rate produced by the two processes leads to a decay constant of about 20 msec for a residual gas pressure of 2×10^{-8} Torr. This loss rate is sufficiently low that other processes such as plasma instabilities and ion cooling by plasma electrons should be easily studied under conditions of relatively poor vacuum in modest apparatus. (C.E.S.)

17366 PARTICLE DYNAMICS IN A BOUNDED REGION. S. Gartenhaus (Purdue Univ., Lafayette, Ind.). Phys. Fluids, 6: 451-2(Mar. 1963).

The effects of external force fields and certain physical situations that cannot be described in terms of small perturbations from equilibrium are included in an analysis of the oscillations of a collisionless electron plasma that is confined to a finite geometry. (C.E.S.)

17367 COMMENTS ON "KINETIC EQUATIONS FOR PLASMAS." Pieter Schram (Institut für Plasmaphysik, Munich). Phys. Fluids, 6: 453-4(Mar. 1963).

It was pointed out that the general conclusion that the usual Fokker-Planck equation has no region of validity, appears to be based on an erroneous estimate of orders of magnitude in the paper "Kinetic Equations for Plasmas" by T. Kaga in Physics of Fluids, 5: 705(1962), NSA 16: 21676. (C.E.S.)

17368 REPLY TO COMMENTS OF PIETER SCHRAM. Toyoki Koga (Univ. of Southern California, Los Angeles). Phys. Fluids, 6: 454-5(Mar. 1963).

Replying to the comment by P. Schram, Phys. Fluids, 6: 453-4(Mar. 1963), an unsound assumption in kinetic equations for plasmas (T. Kaga, Phys. Fluids, 5: 705(1962) NSA 16: 21676) on which current theories are based is mentioned and a recent reconsideration by the author is outlined. (C.E.S.)

17369 COMMENTS ON "CURRENT-LAYER DIFFUSION IN A ONE-DIMENSIONAL PINCH." Ronald F. Probstein and James A. Fay (Massachusetts Inst. of Tech., Cambridge). Phys. Fluids, 6: 456-7(Mar. 1963).

It was pointed out that the boundary condition used in current-layer diffusion in a one-dimensional pinch, in a paper by T. J. Falk and D. L. Turcotte, Phys. Fluids, 5: 1288(1962) NSA 17: 5474, was unrealistic for the diffusional type of problem under consideration. (C.E.S.)

17370 REPLY TO COMMENTS BY PROBSTEIN AND FAY. Theodore J. Falk and Donald L. Turcotte (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 6: 457-8(Mar. 1963).

The boundary condition given by R. F. Probstein and J. A. Fay, Phys. Fluids, 6: 456(1962) for current-layer diffusion in a one-dimensional pinch, originally suggested by T. J. Falk and D. L. Turcotte, Phys. Fluids, 5: 1288 (1962) NSA 17: 5474, was accepted as correct. (C.E.S.)

17371 MICROWAVE DENSITY OF PLASMA. K. H. Schramm (Battelle-Institut E. V., Frankfurt am Main). Phys. Letters, 3: 94-5(Dec. 1, 1962). (In German)

The relation of experimental observations to theoretical predictions of the behavior of micro- and radiowaves in plasma is discussed. The application of Kirchhoff's law to electromagnetic waves in plasma and reflected noise output is also discussed. (M.C.G.)

17372 A VIRIAL THEOREM FOR PLASMAS. S. P. S. Anand and R. S. Kushwaha (Univ. of Delhi). Phys. Letters, 3: 199-200(Jan. 1, 1963). (In English)

The tensor form of a virial theorem for plasma is given, taking into account both electric and magnetic field effects. Only high-frequency behavior is considered, and dynamic effects of ions and collision effects are ignored. The virial theorem is obtained by applying a suitably defined electric-field potential tensor. (T.F.H.)

17373 PROPAGATION OF ELECTROMAGNETIC WAVES IN PLASMAS. Donald F. DuBois, Victor Gilinsky, and Margaret G. Kivelson (RAND Corp., Santa Monica, Calif.). Phys. Rev., 129: 2376-97(Mar. 15, 1963). (RM-3224-AEC)

Green's function techniques are used to treat the propagation of electromagnetic waves in uniform, weakly interacting plasmas near equilibrium in the absence of external magnetic fields. The frequency and the damping of electromagnetic waves in a medium are related to the local complex conductivity tensor, which is calculated by the diagrammatic techniques of modern field theory. Physical quantities are calculated in terms of a consistent many-particle perturbation expansion in powers of a (weak) coupling parameter. An open-diagram technique is introduced that simplifies the calculation of absorptive parts. For long-wavelength longitudinal waves (i.e., electron plasma oscillations) it is found that the main absorption mechanism in the electron-ion plasma is the two-particle collision process appropriately corrected for collective effects and not the one-particle (or Landau) damping process. Electron-ion collisions produce a damping effect, which remains finite for long wavelengths. The effect of electron-electron collisions vanishes in this limit. The absorption of transverse radiation is also considered. The results for the absorptive part of the conductivity tensor for long-wavelength electromagnetic waves in a plasma where the phase velocity ω/k is much greater than the rms particle velocity is derived. The effects of dynamic screening are entirely contained in a definite integral, which is numerically evaluated. The calculations are valid for a range of temperatures and densities. This range makes justifiable the use of Boltzmann statistics, the Born approximation, and the neglect of wave mechanical interference effects. The weak-coupling approximation is also justified. The plasma is in this range if for example, $T > 10^6$ °K and $n < 10^{20}$ particles/cm^3. For these hot plasmas a natural short-wavelength cutoff appears at roughly the thermal de Broglie wavelength. Electrons and ions are found to produce comparable screening effects. To illustrate the application of these techniques to degenerate, low-temperature systems, the absorption process in a high-density electron gas is briefly considered. (auth)

17374 "NEGATIVE" TENSOR SUSCEPTIBILITY IN MEDIA EXHIBITING POPULATION INVERSION. R. L. Fork and C. K. N. Patel (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 129: 2577-9(Mar. 15, 1963).

The results of a theoretical and experimental investigation were described for the tensor dielectric susceptibility of a plasma in which some of the participating atoms exhibit population inversion. The measurement of the real part of the tensor dielectric susceptibility in the vicinity of an optical resonance was difficult because of the large absorption near resonance; however, by examining a resonance for which the levels exhibit population inversion, a direct measure of the real part of the susceptibility was obtained by observing the "negative" Faraday rotation, i.e., "negative" circular birefringence associated with the resonance. For levels with inverted populations the com-

plement of the inverse Zeeman effect was observed, viz., a Zeeman splitting of the gain curve in the amplifying medium. The high-gain $5d[3/2]_1^0 - 6p[3/2]_1$ transition of atomic xenon at 2.026 μ in a helium–xenon mixture was used for these measurements. The observed results were consistent with the theory. (auth)

17375 PLASMONS, GAUGE INVARIANCE, AND MASS. P. W. Anderson (Bell Telephone Labs., Murray Hill, N. J.). Phys. Rev., 130: 439-42(Apr. 1, 1963).

Schwinger has pointed out that the Yang-Mills vector boson implied by associating a generalized gauge transformation with a conservation law (of baryonic charge, for instance) does not necessarily have zero mass, if a certain criterion on the vacuum fluctuations of the generalized current is satisfied. It is shown here that the theory of plasma oscillations is a simple nonrelativistic example exhibiting all of the features of Schwinger's idea. It is also shown that Schwinger's criterion that the vector field $m \neq 0$ implies that the matter spectrum before including the Yang-Mills interaction contains $m = 0$, but that the example of superconductivity illustrates that the physical spectrum need not. Some comments on the relationship between these ideas and the zero-mass difficulty in theories with broken symmetries are given. (auth)

17376 STABILITY OF CONDUCTING PLASMA CYLINDER IN MAGNETIC FIELD. Yu. V. Vandakurov. Priklad. Mat. i Mekhan., 27: 46-54(Jan.-Feb. 1963). (In Russian)

Stability of a high-conductance plasma pinch was studied for an incompressible hollow cylinder, an incompressible solid cylinder, and a compressible hollow cylinder. The solutions correspond to unstable oscillations with purely exponential functions of time. The instabilities develop due to interruptions in the volume density of stationary current. (R.V.J.)

17377 PROPAGATION OF SHOCK WAVE IN A PLASMA ALONG A MAGNETIC FIELD. A. D. Pataraya. Priklad. Mat. i Mekhan., 27: 85-90(Jan.-Feb. 1963). (In Russian)

Propagation of a single wave along a magnetic field in a two-dimensional collision-free quasi-neutral plasma was studied. It was found that for an isolated compression wave in cold plasma the positive charge is found near a plasma density maximum and the negative charge further from the maximum. The magnitudes of the half-width and wave velocity are found for weak waves as well as for quasi-neutral conditions in hot plasma. It was also found that magnetosonic motion deforms the wave profile. (R.V.J.)

17378 THERMONUCLEAR REACTIONS. FUTURE ENERGY SOURCES. Max Hoyaux. Rev. Gen. Electronique, 16: No. 193, 47-57(Dec. 1962). (In French)

The five most promising approaches to the containment and stabilization of thermonuclear reactions are described. They are the plasma pinch, the stellarator, magnetic mirror machines, cuspidate geometry, and the Astron. The auxiliary problems connected with these approaches are indicated. In conclusion, the probable role of thermonuclear energy in future energy programs is assessed. (J.S.R.)

17379 INVESTIGATION OF ESCAPE OF CHARGED PARTICLES FROM A PLASMA IN A MAGNETIC FIELD. L. L. Pasechnik and O. V. Kozak (Inst. of Physics, Kiev). Ukr. Fiz. Zh., 7: 1165-71(Nov. 1962). (In Ukrainian)

The escape of charged particles from a plasma was studied with an inclined cathode at low pressure in a magnetic field. The existence of critical magnetic fields H_{cr}, is established with which escape of particles from the plasma sharply increases. The value of H_{cr} rises with an increase in magnetic field. A connection is established between the increase in the escape of charges and the appearance of intense oscillations with a frequency of approximately 10^7 cps. (auth)

17380 SPECTROSCOPIC MEASUREMENTS ON A TITANIUM PLASMA GUN WITH HYDROGENATED ELECTRODES. H.-W. Drawin (EURATOM-CEA Fontenay-aux-Roses, France). Z. Physik, 172: 181-201(1963). (In English)

The plasma produced by a plasma gun which consists of concentric titanium and tantalum washers was observed in the plasma gun as well as in a drift tube in which the plasma particles were injected. Axial drift velocities of hydrogen and impurities were determined in the drift tube by optical time-of-flight measurements. Maximum hydrogen velocities between 9×10^6 to 1×10^8 cm/sec could be determined, in agreement with magnetic probe-, Faraday cup-, microwave-, and electrostatic energy analyzer measurements. The plasma which is produced within the plasma gun by a powerful discharger (vacuum arc) was observed with a framing camera, spectrographs and photomultipliers. From end-on observed time resolved spectrograms the temperatures and electron densities were determined as a function of time. The measurements indicate that thermal equilibrium is reached about 2.5 μsec after the firing of the main discharge and 4 μsec after the beginning of the main discharge a maximum temperature of about 72000°K is reached. The measurements further indicate that the high-energy part of the ejected particles is produced before an equilibrium state in the plasma gun has been established. (auth)

17381 STABILITY OF A ROTATING PINCH. J. N. Tandon and S. P. Talwar (Univ. of Delhi). Z. Physik, 172: 402-4(1963). (In English)

The problem of pinch stabilization is of interest in connection with plasma confinement and was the subject matter of various investigations in recent years. The theoretical investigations in the past were restricted to static equilibrium configurations. It is of interest to explore whether an initial motion of plasma tends to make the pinch more, or less stable than when the fluid velocity is zero. The axisymmetric stability of an infinitely long cylindrical plasma column of radium R rotating uniformly with angular velocity Ω about the Z-axis was investigated, the fluid being assumed to the incompressible, inviscid, and of infinite electrical conductivity. The plasma carries a uniform axial current of density f_0 and a uniform axial magnetic field H_1. The field outside is taken to be H_2 in Z-direction and a toroidal component which is continuous across the boundary. (auth)

17382 ON THE SPECTROSCOPIC TEMPERATURE AND DENSITY MEASUREMENT OF PLASMA IN THE ABSENCE OF THERMODYNAMIC EQUILIBRIUM. Hans-Werner Drawin (Euratom-CEA, Paris). Z. Physik, 172: 429-52(1963). (In German)

After a discussion of the ionization formulas for both a steady-state and a transient plasma with and without thermodynamic equilibrium it is shown that for the practical application of these formulas the introduction of a non-Maxwellian velocity distribution function for the electrons is necessary in special cases, because the electrons can escape from the plasma without effecting a sufficiently high number of ionizing impacts. The influence of both the "Maxwell" and the "Druyvesteyn" distribution on the excitation, ionization, and recombination processes is treated quantitatively. The modification of the ionization formula due to three-body collisional recombination into excited

states is discussed. It is emphasized that the normally unknown velocity distribution of the electrons can be obtained by measuring the free-bound recombination continuae. (auth)

17383 SOME DATA ON THE ROTATIONAL MAGNETO-MECHANIC EFFECT IN A LOW-PRESSURE PLASMA. E. I. Urazakov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 41-4(Jan. 1963). (In Russian)

The rotational magneto-mechanic effect in a low pressure plasma previously discovered is studied quantitatively. The dependence of the angular momentum in the plasma on the magnetic field strength, pressure and nature of gas and magnitude of current flowing through the plasma are determined. The rotational magneto-mechanical effect has also been detected in the plasma of inert gas produced by a high frequency field. (auth)

17384 KINETIC PROPERTIES OF A RAREFIED PLASMA WITH A LARGE RADIATIVE PRESSURE AND MUTUAL ELECTRON-PHOTON DRAG EFFECTS. L. E. Gurevich and V. I. Vladimirov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 166-76 (Jan. 1963). (In Russian)

An investigation is carried out on the kinetic coefficients in a rarefied plasma with large radiative pressure in which the electron and photon ranges are restricted by Compton scattering. It is shown that mutual dragging between the electrons and photons leads to a decrease of the electric conductivity and to a sharp increase of the thermal emf compared to those in a plasma with pure Coulomb scattering. It is shown that scattering on photons eliminates electron escape. In a wave moving along the magnetic field in a definite frequency range a cyclotron type resonance may appear, at a frequency, however, of $\omega = \Omega/2$. (auth)

17385 THE EFFECT OF POLARITY ON THE PHYSICAL CHARACTERISTICS OF THE PLASMA STREAM OF AN ARC GENERATOR. L. I. Grechikhin (Inst. of Physics, Academy of Sciences, Minsk, BSSR). Zhur. Analit. Khim., 18: 20-3(Jan. 1963). (In Russian)

The effect of polarity on the physical characteristics of the plasma stream of an arc generator was studied. When the outlet nozzle is a cathode, the stream of the plasma generator is unstable, the temperature in the stream is high, and the spectral lines are considerably widened. When the outlet nozzle serves as an anode, the stream is stable, there are no sharp jumps of the temperature, and the spectral lines are rather clear. An explanation to these facts is given. (auth)

17386 PHYSICS OF FULLY IONIZED GASES. Second Revised Edition. Lyman Spitzer, Jr. Interscience Tracts on Physics and Astronomy. New York, John Wiley and Sons, Inc., 1962. 179p. $4.75.

This second edition also examines particle motion, macroscopic behavior of plasma, and encounters between charged particles. The section on plasma waves has been rewritten and expanded, and a new section on hydromagnetic equilibria and their stability is included. Provision of a theoretical understanding of the subject is the object of the book. 91 references. (D.C.W.)

17387 SPARK GAP, 50 TO 80 kv, MODEL 3 (Engineering Materials). (Los Alamos Scientific Lab., N. Mex.). 5 drawings. (CAPE-936)

This spark gap was designed as a four-element gap for use in each capacitor bank of the magnetic compression experiments, Scylla IV. The design is similar to the 100 kv gap used in both Scylla I & II. The spark gap will operate without maintenance for over 1000 shots and has less than 10^{-8} second jitter. (F.L.S.)

17388 VOLNOVYE I KOLEBATEL'NYE YAVLENIYA V ELEKTRONNYKH POTOKAKH NA SVERKHVYSOKIKH CHASTOTAKH. (Wave and Oscillation Effects in Super-High Frequency Electron Flux). V. I. Shevchik, G. H. Shvedov, and A. V. Soboleva. Publishing House of Saratov Univ., 1962. 336p.

Physical aspects of electron waves and oscillations in various super-high frequency systems are surveyed. Studies are confined to space-change waves and oscillations in electron beams in longitudinal and crossed electric and magnitude fields. An extensive reference list is included. (R.V.J.)

17389 SMALL AMPLITUDE WAVES IN A TWO-COMPONENT FULLY IONIZED GAS. Harold Searl Dunn. Thesis, Providence, Brown Univ., 1962. 56p.

The propagation of small amplitude waves in a two-component fully ionized gas is discussed from the point of view of a boundary-value problem, the so-called "piston problem." The gas is assumed to occupy the half-space $x > 0$, and to be bounded at $x = 0$ by a rigid non-conducting wall, the "piston." It is further assumed that the gas is initially at rest in a state of thermodynamic equilibrium. For $t > 0$, the piston is given a uniform motion into the gas. It is shown that two wave fronts propagate into the ionized gas, one at the ion sound speed, and the other at the much higher electron sound speed. The wave form changes during the course of propagation as a result of the electrostatic restoring force between the ions and electrons, and also as a result of the inelastic collisions between the two types of particles. When energy exchange between the two gases is neglected, the equations describing the ion-electron gas may be interpreted as the governing equations of a pair of stretched parallel strings coupled to one another by springs and viscous elements. In this mechanical analogue, the displacement of one string corresponds to the ion velocity, and the displacement of the other to the electron velocity. The springs represent the electrostatic restoring force while the viscous elements correspond to the effects of the inelastic ion-electron collisions. (M.P.G.)

17390 IMPROVEMENTS IN PLASMA CONTAINING DEVICES. (to General Dynamics Corp.). British Patent 918,741. Feb. 20, 1963. Priority date June 10, 1959, United States.

A high energy plasma containing device with an improved means for maintaining confining pressure is described. The device includes means for producing magnetic confining fields by utilizing alternating current techniques and means for producing alternating magnetic confining fields that make energy extraction relatively simple. (C.E.S.)

17391 GENERATION OF EXTREMELY HIGH TEMPERATURE. Hannes Olof Goesta Alfven. U. S. Patent 3,074,875. Jan. 22, 1963. Priority date Oct. 1, 1958, Sweden.

An apparatus for producing gaseous plasma with extremely high temperature is described. Deuterium or tritium is rarified in a container in a uniform magnetic field of 1 to 10 kilogauss. An additional nonuniform magnetic field is also provided in the annular space between an inner and outer electrode. A voltage from 10 kv up to 200 kv is applied to the electrodes, which ionizes the gas and causes a discharge between the electrodes. This causes a hot circulating plasma to be formed, which is further heated by the nonuniform magnetic field, causing thermonuclear reactions to take place. The design of the apparatus and variations of the design are described in detail. (M.P.G.)

Shielding

Refer also to abstract 17466.

17392 (GAMD-2271) AN OPTIMUM SHADOW SHIELD. J. J. Tillotson (General Atomic Div., General Dynamics Corp., San Diego, Calif.). May 18, 1961. Contract AF 29(601)-2207. 21p.

The method of Lagrange multipliers is used with the Euler-Lagrange equation of variational calculus to develop a method for designing an optimum shadow shield for an isotropic point source subject to the requirements of a specified total attenuation within a given solid angle, a shield position at a given distance from the source, and a specified shape of the outer surface. Following a general treatment, the cases of flat, parabolic, and spherical outer surfaces are examined. Thicknesses of some flat and parabolic shields for several attenuations are included. (D.C.W.)

17393 (NP-12611) A COMPUTATION METHOD FOR GAMMA-RADIATION INTENSITY IN THE PRESENCE OF GENERAL SHIELDING AND SOURCE CONFIGURATIONS. R. R. Putz and A. Broido (California. Univ., Richmond. Inst. of Engineering Research). Dec. 18, 1957. Contract CD-GA-56-57. 37p.

A method for computing the gamma radiation intensity at a point in a complex (a house, for instance) resulting from a distributed gamma source (fallout) behind shielding of varied geometry (walls, etc.) is discussed. Approaches to the problem are summarized, and the nature of input-output data for computer handling of calculations is described. Particular attention is given to accurate determination of the buildup factor, and sample calculations are presented. (D.C.W.)

17394 INTENSIFICATION FACTOR OF LEAD SCREEN FOR γ-RAY RADIOGRAPHY. Shigemasa Enomoto, Tomihiko Furuta, and Nobuo Wada (Government Industrial Research Inst., Nagoya, Japan). Radioisotopes (Tokyo), 11: 275-82(Aug. 1962). (In Japanese)

The intensification of γ radiation emitted by Cs^{137} and Co^{60}, as a result of multiple interactions in Pb screens, is analyzed photometrically. (T.F.H.)

17395 ELECTROSTATIC SHIELDING FOR SPACE VEHICLES. F. H. Vogler (Lockheed-Georgia Co., Marietta, Ga.). Preprint Paper No. 63-12. New York, Institute of the Aerospace Sciences, 1963. 38p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

An analysis was made of the capability of an electrostatic field as a shield against charged particle radiation. The radiation source used was the inner Van Allen belt. The configuration investigated was the field between two concentric, spherical conducting surfaces. The volume protected was the space enclosed by the inner spherical surface. Shielding was achieved through the deflection of particles away from the inner sphere. (C.E.S.)

Theoretical Physics

17396 DETERMINATION OF THE EIGEN-ENERGIES AND FUNCTIONS FROM THE MAXWELL-BOLTZMANN DENSITY OPERATOR. II. CASE OF PERTURBED SYSTEMS. Pierre Smet and Jacques Tillieu (Faculté des Sciences, Lille, France). J. Phys. Radium, 23: 939-44 (Nov. 1962). (In French)

Previously described methods for the determination of eigen-energies and corresponding projectors from the Maxwell-Boltzmann density operator are adapted to a perturbed system. As an example, the anharmonic oscillator problem is examined. (auth)

17397 ON LINEAR AND NON-LINEAR HYDROMAGNETIC FLUID MOTION GENERATED BY OSCILLATING SOLID BOUNDARIES. PART I. A. Kildal (Euratom-CEA, Paris). Z. Physik, 172: 49-67(1963). (In English)

An investigation of the generation of second order vorticity (streaming) in an electric conducting, viscous, and compressible fluid embedded in an external magnetic field. The equations used are those pertaining to the one-fluid model. Equations for the generation of fluid vorticity as well as magnetic vorticity were derived. By using the method of successive approximations, the systems of equations of first and second order were developed. By the use of dimensional analysis the importance in the vorticity generation of the different generating terms was investigated. The linear equations for two-dimensional problems were solved in the case of fluid motion above a flexible plate, vibrating in an external magnetic field. (auth)

17398 ANALYTIC PROPERTIES OF THE SCATTERING AMPLITUDE ON THE FIRST NONPHYSICAL SHEET. D. Ya. Petrina (Inst. of Mathematics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 44: 151-6 (Jan. 1963). (In Russian)

The analytic properties of partial waves and the scattering amplitude on the first non-physical sheet are investigated. A proof is given of the Mandelstam representation for each term of the expansion of the scattering amplitude in a series in the parameter. (auth)

17399 ON THE EXISTENCE OF A MONOPOLE. L. M. Tomilchik (Inst. of Physics, Academy of Sciences, Belorussian SSR). Zh. Eksperim. i Teor. Fiz., 44: 160-1(Jan. 1963). (In Russian)

It is suggested that the Dirac monopole may be forbidden by parity conservation in electromagnetic interactions. This hypothesis in a natural way explains the futility of attempts of an experimental detection of the monopole. (auth)

17400 MICROCOVARIANCE AND MICROCAUSALITY IN QUANTUM THEORY. Yu. M. Shirokov (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 203-24(Jan. 1963). (In Russian)

Quantum theory microcovariance conditions are obtained which reflect the fact of pseudoeucleadicity of space-time at all points. The microcausality conditions in relativistic quantum theory are also formulated. For deducing all these conditions only the basic principles of quantum theory and geometric space-time properties were employed. In particular the particles are not assumed to be points and none of the postulates of quantum field theory are invoked. A new class of physical quantities called dynamical momenta are introduced in relativistic quantum field theory. With the aid of the dynamical momenta the matrix elements of various currents can be exactly connected with the scattering matrix without making recourse to the postulates of quantum field theory. In conjugation with the general conditions of microcovariance and microcausality, application of dynamical momenta makes it feasible to set up an experimental program for investigating the limits of applicability of the existing concepts regarding the structure of space-time. It is shown that the existence of the Hamiltonian description is a direct consequence of the two postulates: 1) existence of the S-matrix, 2) pseudoeucleadicity of the space-time. (auth)

17401 THEORETICAL PHYSICS. A[leksandr] S[olomanovich] Kompaneets (Kompaneyets). Translated from Russian. Moscow, Foreign Languages Publishing House, 1961. 594p.

This second edition includes rearranged sections on electrodynamics and mechanics. The section on quantum mechanics has been expanded, and an introduction to Gibb's method is included in the section on statistical physics. (D.C.W.)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 16261, 16310, 16525, 16760, and 16940.

17402 (AECL-1684) HIGHLIGHTS OF CHALK RIVER WORK ON THE PHYSICS OF HEAVY WATER LATTICES SINCE THE 1959 IAEA PANEL MEETING. R. E. Green, H. Maerkl, C. B. Bigham, A. Okazaki, J. W. Hilborn, and E. Critoph (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1962. 61p.

Results of experiments on ZED-2 (enlarged ZEEP) are presented. Analyses of these results were made by calculating lattice parameters and by comparing bucklings obtained from these parameters with experimental bucklings. Other work is reported on reaction rate measurements in a hot ZEEP reactor channel, reactor fuel changes resulting from long-time irradiation, startup and operation of NPD-2, and conversion of NRX to natural UO_2 rods on power step-up to 42 Mw. (J.R.D.)

17403 (ANL-6640) PROCEEDINGS OF THE AMU-ANL SUMMER STUDY PROGRAM, JUNE 19–JULY 14, 1961. G. E. Schweitzer, comp. (Argonne National Lab., Ill.). Nov. 1962. Contract W-31-109-eng-38. 409p.

Notes and edited data from lectures are presented on the history and development of the EBWR, experimental and support study facilities at ANL, EBWR components and materials design, shielding, control rods and control rod drives, fuel design and behavior, water chemistry and corrosion, heat transfer, reactor physics, reactor instrumentation, and reactor safety. (J.R.D.)

17404 (BNL-164) PROGRESS REPORT ON THE REACTOR SCIENCE AND ENGINEERING DEPARTMENT, OCTOBER 1–DECEMBER 31, 1951. Clarke Williams (Brookhaven National Lab., Upton, N. Y.). Contract [AT (30-2)-Gen-16]. 28p.

Work on liquid metal fuel reactor components, studies of normal water 1% enriched U-fueled reactor components, and other research and development programs are reported. Progress in shielding research is also reported along with work on volatile fluorides, reactor theory, and radiation effects on metals. (J.R.D.)

17405 (CEA-2174) SÉCURITÉ DANS LE CONTROLE DES PILES ATOMIQUES (THESES). (Safety Precautions in Atomic Pile Control (thesis)). Jacques Furet (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 277p.

The problem of safety in atomic pile control was studied. The wishes occurring in piles during their operation and also their behavior in the dynamic state were considered. The importance of intrinsic safety devices, the influence of reactivity variations on the power fluctuations during accidental operation, and the development of robust and reliable safety appliances are discussed. The starting-up accident was especially studied both for low-flux piles where a compromise is necessary between the response time of the safety appliances and the statistical fluctuations, and for high-flux piles where xenon poisoning has an effect on the lower limit of the velocity of reactivity liberation. The desirability was stressed of automation as a safety factor in atomic pile control. (auth)

17406 (EURAEC-519) AN ADVANCED RESEARCH PROGRAM ON THE APPLICATION OF STEAM-WATER SPRAY TO THE COOLING OF LIGHT WATER REACTORS. CAN-2 Quarterly Progress Report No. 6, October 1–December 31, 1962. (Centro Informazioni Studi Esperienze, Milan). Jan. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 060-61-7 RDI. 12p. (CISE-R-70)

Heat transfer experiments were performed with a tubular test element 0.918 cm ID. Three values of the heated length were investigated: 139.9, 69.7, and 35.0 cm. Measurements were made of critical heat fluxes and heat transfer coefficients. The hysteresis effect of the heat transfer coefficient was also investigated. Pressure drops were measured both with and without power. The codes for data reduction are being translated into the language of the electronic computer Olivetti 6001, which will be installed at CISE. Hydrodynamic experiments with the adiabatic loop at room temperature were devoted to the following subjects: liquid film thickness and pressure drop as a function of mass flow rate at various gas densities at the highest position of the test section; variation of phase and velocity distribution along the flow direction at two different gas densities; and phase and velocity distribution as a function of mass flow rate at two gas densities at the highest position of the test section. Preliminary experiments in single phase flow were completed for testing the devices to measure the flow rate in the liquid film and the shear stress on the duct wall. Corrosion tests on Zircaloy-2 and stainless steel specimens were pursued, reaching exposure times of about 6000 hours. Tests with controlled oxygen contents in the steam-water mixture are in progress. Zircaloy-2 specimens were subjected to metallographic examinations in order to investigate the oxide layer. Evidence was found of the absence of extraneous deposits (like iron oxide). (auth)

17407 (EURAEC-537) DEVELOPMENT PROGRAM ON THE APPLICATION OF STEAM-WATER SPRAY TO REACTOR COOLING. CAN-3 Quarterly Progress Report No. 4, October 1–December 31, 1962. (Centro Informazioni Studi Esperienze, Milan). Jan. 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 056-62-1 RDI. 14p. (CISE-R-71)

Construction of the facility for large scale heat transfer experiments was completed in Genoa. Preliminary tests were started except for high pressure tests which had to be postponed due to the delayed completion of the boiler maintenance work. Nevertheless it was possible to perform a first ignition test. In the preparation of the in-pile experiments, the activity concerned out-of-pile assembly of the whole loop, test and calibration of the loop, start of out-of-pile corrosion tests on Zircaloy-2 specimens, analytical problems, and static corrosion experiments. (auth)

17408 (EURAEC-584) STATISTICAL METHODS FOR HOT CHANNEL AND HOT SPOT CALCULATION. Quarterly Progress Report, October 1, 1962–December 31, 1962. (FIAT. Sezione Energia Nucleare, Turin). Jan. 31, 1963. Work Performed under United States–Euratom Joint Research and Development Program. Contract 035-60-11 RDI. 8p. (FN-E-31)

The work of debugging and testing of the HYTHEST

Code was completed. The use of this code in order to obtain extensive numerical results about "spot model" correction factors and to compare them with those obtained by conservative methods was initiated. SENN core geometrical characteristic and operating performances were collected and are being mainly used as a reference in the comparison work above mentioned: a parametric study is being carried varying the standard deviations of the statistical independent parameters. Work was initiated related to the definition of the thermal and hydraulic model for an ORGEL type core: this model will be used in a Monte Carlo Code for evaluation of the correction factors for such a reactor. (auth)

17409 (GEAP-3811) SODIUM COOLED REACTORS PROGRAM. FAST CERAMIC REACTOR DEVELOPMENT PROGRAM SUMMARY REPORT, JULY 1959–SEPTEMBER 1961. F. J. Leitz, ed. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Contract AT (04-3)-189. 142p.

A summary of work on the Fast Ceramic Reactor program is presented. The work was previously reported in a series of progress reports and in several topical reports. Information is included concerning fabrication and irradiation of Pu oxide–U oxide systems, reactor safety analysis, and preliminary reactor design. Other information is included on additional reactor and fuel development tasks initiated as a follow-up to further develop the fast ceramic reactor concept, vented fuel, mixed carbides, and fuel fabrication. (J.R.D.)

17410 (GEAP-3914) IN-CORE POWER MONITORING OF NUCLEAR REACTORS. R. A. DuBridge (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Apr. 15, 1962. Contract AT(04-3)-189. 130p.

Results of a study are presented in which it is shown that the absolute macroscopic power distribution in a reactor can be continuously monitored by dividing the reactor into N monitoring volumes, measuring average gamma or neutron flux in each, and relating this to total measured reactor power. This system provides a continuous knowledge of the reactor's gross power distribution, and is a powerful tool for operating at optimum power distribution. In addition, periodic flux mappings and spectrum mappings can provide a microscopic picture of power distribution. It is concluded that both gamma and neutron flux can be used as parameters of power for power monitoring purposes. Gamma has the advantage of the availability of drift-free detectors, while neutrons have the advantage of fast response to power changes. The problems of fuel isotopic changes, non-uniform moderators, and averaging ability of power parameters are discussed. Results of analyses concerning the problems and operation of ion chambers and heating-type detectors are also included. (J.R.D.)

17411 (GEMP-177C) HIGH-TEMPERATURE MATERIALS AND REACTOR COMPONENT DEVELOPMENT PROGRAMS. VOLUME III. REACTOR COMPONENT DEVELOPMENT. Second Annual Report. (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). Feb. 28, 1963. Contract AT(40-1)-2847. 65p.

Development programs reported include those concerning circulating ball reactivity control with capability of operating around sharp bends; static switching utilizing solid-state devices; capacitance temperature sensor based on the change in dielectric constant of alumina or beryllia versus temperature change; high-temperature extension of conventional nuclear sensors (fission counters and d-c ionization chambers); development of nuclear sensors for monitoring and controlling high-temperature, high-performance reactors; high-temperature fasteners involving stress relaxation of Inconel bolts and nuts up to 600°C; fasteners for remote maintenance; Monte Carlo program for nuclear analysis of complex reactor and shield systems. Significant results achieved on these programs are summarized. A scram actuator employing three electromagnetic units, a straight guide tube, and a segmented rod capable of operating around bends demonstrated scram performance competitive with spring scram actuators. A five-channel safety scram bus occupying a volume $5 \times 6 \times 3.5$ in. was tripped 90,000 times in a period of 770 hours without a failure or sign of circuit deterioration. The determination of temperature by sensing the change in dielectric constant of ceramic materials was established as a method capable of good sensitivity and resolution by testing up to 3000°F. The feasibility of using a charged fragment detector without external power being applied to the detector to detect thermal neutrons was demonstrated. The problems associated with the use of Inconel X screw type fasteners at temperatures up to 1100°F were defined but not resolved. (auth)

17412 (GNEC-264) DEVELOPMENT OF HYDRAULIC BALL (HY-BALL) CONTROL SYSTEM. Quarterly Progress Report No. 2, October–December 1962. S. J. Weems, S. E. Turner, R. L. Lyerly, and R. W. Taylor, Jr. (General Nuclear Engineering Corp., Dunedin, Fla.). Jan. 2, 1963. Contract AT(38-1)-207. 96p. (EURAEC-533)

A preliminary design of a boiling-water reactor using conventional zircaloy-clad UO_2 rods as fuel and controlled by hydraulic ball (Hy-Ball) columns was established. Mechanical design studies indicated that the control lines should be connected to the Hy-Ball column storage hopper (outlet) rather than the inlet. This piping arrangement holds the Hy-Balls in the core during either a reactor vessel loss-of-pressure accident or a reactor pressure surge. A thermal design study was initiated and parameters developed to study the effects of steam formation on Hy-Ball system operation. Results indicated that the major effect of steaming is to cause the columns to be lifted at a slower rate than is the case without steaming. Operation and scram tests were run on the five-pass system using $\frac{1}{2}$-in. diameter balls in $\frac{9}{16}$-in. ID tubing. Performance was demonstrated to be satisfactory, but some of the balls would not return to the in-core position because of friction in the turn-around section at the bottom of the "U" tube legs and voids in the system accumulated into elongated bubbles in the down-flow passes and caused some oscillation of the balls in the hoppers. Tests with the cold loop on the parallel-stepped system demonstrated satisfactory operation. Cold-loop operation and scram tests demonstrated satisfactory operation of the $\frac{1}{2}$-in. balls in $\frac{9}{16}$-in. ID columns without any significant vibration. The reference design of the hot-test loop was completed. (M.C.G.)

17413 (HW-74549) PROGRESS REPORT ON FUEL RE-USE: ANALYSIS OF A FAST-THERMAL REACTOR COMPLEX. R. J. Hennig, P. L. Hofmann, and G. J. Busselman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1, 1963. Contract AT(45-1)-1350. 51p.

A preliminary evaluation of fuel re-use (consecutive irradiation of fuel elements in different reactor regimes) for a specific fast-thermal reactor complex is presented. The system considered consists of the breeding blanket of a Na-cooled, PuO_2–UO_2-fueled, fast reactor (which is used as a Pu enrichment facility) and a D_2O-moderated

and -cooled thermal reactor of the pressure tube type. Fuel is cycled between these two reactors and the fuel costs of the thermal reactor are evaluated as a function of various economic parameters. Based upon the single reactor complex examined, fuel re-use appears to offer an attractive approach for reducing fuel costs. When the fast reactor fuel costs are maintained unchanged, fuel cost reductions for the thermal reactor approach 1 mill/kw-hr. (auth)

17414 (HW-SA-2922) A PROPOSED DRIVE FOR ESSENTIAL PUMPS OF A LARGE REACTOR. D. W. McLenegan (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 20, 1963. Contract AT(45-1)-1350. 20p.

The proposed drive is an all-electric system involving 2 motors per pump drawing power from independent sources, and providing flexible operation of a single battery of pumps to meet either normal coolant flow needs or the reduced-flow requirements following a scram. A high degree of protection and high operating efficiency are thought possible. (J.R.D.)

17415 (HW-SA-2933) ANALOGIES BETWEEN PROBLEMS IN REACTOR THEORY AND ELECTRICAL ENGINEERING. R. E. Peterson and R. L. Watts (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Feb. 1963. Contract AT(45-1)-1350. 21p.

Analogies between nuclear reactors and more conventional energy sources are discussed. Sections are included concerning terminology and concepts, neutron transport, reactor statics and electromagnetic theory, and reactor kinetics and electric transients. (J.R.D.)

17416 (IDO-16830) ORGANIC REACTOR TECHNOLOGY QUARTERLY REPORT, JULY 1–SEPTEMBER 30, 1962. (Phillips Petroleum Co., Bartlesville, Okla. and Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Jan. 18, 1963. Contracts AT(10-1)-1080 and AT(10-1)-205. 111p.

The effect of high boiler content on film formation was studied in circulating loop tests in the large rig. Film weight increased exponentially with high boiler content. In these same tests charges generated on the particulate matter or coolant molecules caused them to flow to a positively charged plate in the radiation beam at a much higher rate than to one negatively charged. Out of the beam the relative potential of the plates was immaterial. In the small rocking cell, a maximum in fouling occurred at about 3% high boiler concentration. A similar maximum was observed at 4% high boiler in the pyrolytic film apparatus. A new "micro-loop" was built and in initial operation gave promise of being a valuable tool in evaluating effects of coolant composition on film deposition. It was demonstrated that iron percarbide is formed by CO reduction of Fe from an iron chelate solution only on metal surfaces where reaction is rapid. In the bulk of the solution, where carburization is slow because of lower temperature, reaction with more Fe produces cementite. Radiolysis of simple aromatic mixtures of benzene and polyphenyls showed that approximately equal amounts of radicals were produced from isomeric polyphenyls but that they differed in their scavenging ability. Similarity between the values found in the radiolytic work and with chemically generated radicals suggests a free radical mechanism for the radiolysis. The nature of the highly colored impurities in commercial Santowax was investigated further, as were the constituents of irradiated polyphenyls by mild oxidation methods. A number of new gas-solid chromatographic column packings were developed which in combination make possible the complete separation and analysis of all the polyphenyls through hexaphenyls. Reclamation of high boilers by hydrocracking is a feasible and economical operation. Final tests to complete data on treating low concentrations of first generation polymer were made, and final report writing begun. An out-of-pile component development test loop was operated with Santowax OMP at temperatures of 700°F in conjunction with Chempump tests. The initial sample design for the Fuel Technology Loop is presented, together with details of instrument lead-out. Several capsules were irradiated in the MTR hydraulic rabbit facility. Results indicate the capsule design is suitable for film formation studies. Several additional organic-containing capsules were irradiated at closely controlled temperatures in the same facility. The pyrolytic capsule fouling test apparatus using resistance thermometry was tested. Pool boiling heat transfer data for Santowax were obtained. Operating personnel continue to direct a major effort toward evaluating the design, construction, and operability of the EOCR. This work is accomplished primarily as a by-product of preparing plant testing and operating manuals. Close liaison was maintained with the architect-engineer and construction contractor throughout the reporting period. Plant component tests were witnessed by operating personnel. During the quarter the first plant facility was transferred to Phillips at which time system testing commenced. Preparations continue for testing other plant systems as they are transferred to Phillips. During the quarter increased effort was expended in preparation for takeover and operation of the plant. Operating personnel were added to the staff; initial supply of organic coolant for operation of the EOCR was received; reactor fuel, handling tools, materials, etc, are in the procurement stage. Overall completion of the EOCR (excluding experimental loops) is estimated to be 97%. (auth)

17417 (KR-35(Vol. I)) ADVANCED COURSE ON THE DYNAMIC BEHAVIOUR OF BOILING WATER REACTORS ORGANIZED BY THE NETHERLANDS'-NORWEGIAN REACTOR SCHOOL AT INSTITUTT FOR ATOMENERGI, KJELLER, NORWAY, 20th AUGUST–31st AUGUST 1962. VOLUME I. (Netherlands'–Norwegian Reactor School. Advanced Study Inst., Kjeller, Norway). 1962. 208p.

Lectures on the dynamic behavior of Boiling-Water Reactors are presented. Topics covered include: nuclear reactor dynamics, measurement of void reactivity, boiling water heat transfer, two-phase flow, demonstration of natural circulation and hydraulic oscillations, calculation of the void and temperature coefficients of reactivity, calculation of subcooled voids, calculation of steady-state hydraulics, and stability studies of natural-circulation boiling-water reactors. (M.C.G.)

17418 (KR-35(Vol. II)) ADVANCED COURSE ON THE DYNAMIC BEHAVIOR OF BOILING WATER REACTORS ORGANIZED BY THE NETHERLANDS'-NORWEGIAN REACTOR SCHOOL AT INSTITUTT FOR ATOMENERGI, KJELLER, NORWAY 20th AUGUST–31st AUGUST 1962. VOLUME II. (Netherlands'–Norwegian Reactor School. Advanced Study Inst., Kjeller, Norway). 1962. 173p.

Lectures on the dynamic behavior of boiling-water reactors are presented. Topics covered include: measurements and interpretation of transfer functions and hydrodynamic instabilities in boiling loop experiments, dynamics of boiling-water reactors, and fuel-temperature dynamics. (M.C.G.)

17419 (MITNE-26) HEAVY WATER LATTICE PROJECT ANNUAL REPORT. Irving Kaplan, A. E. Profio,

and T. J. Thompson, eds. (Massachusetts Inst. of Tech., Cambridge). Sept. 30, 1962. Contract AT(30-1)-2344. (NYO-10208). 70p.

Research on material buckling for lattices with natural uranium involved developing configurations to provide an incoming flux appropriate for macroscopic and microscopic measurements. Analytical and experimental methods giving accurate results were devised; computer codes for deriving buckling from measured flux traverses were arranged. The macroscopic flux distribution was found to have a simple form throughout most of the system. Buckling values for triangular lattices of 1.0 inch diameter natural U rods in 4.5, 5.0, and 5.75 in. lattice spacing were determined and compared favorably with other results. Measurements of axial and radial traverses were made for a triangular lattice of 0.25 in. diameter rods containing 1.03% U^{235} with 1.25 in. lattice spacing. A new method was developed for measuring the ratio of the fission rate in U^{238} to the fission rate in U^{235}, and the effects of varying experimental conditions on the ratio were examined. Measurements of the ratio for a single 1.0 in. diameter natural U rod in heavy water and for triangular lattices of such rods with 4.5, 5.0, and 5.75 in. spacings showed the ratio for the tightest lattice to be only about 6% greater than for the single rod. A ratio of 0.0126 ± 0.0004 was obtained for a single U rod 0.25 in. in diameter with a U^{235} concentration of 1.143% in heavy water. Measurements of the ratio of the epicadmium to subcadmium fission rates in U^{235} were made for a single rod and three lattices; the results were compared with ratios calculated from gold–cadmium ratios. Similar research was done on lattices of enriched uranium rods. Study of resonance capture in U^{238} involved measurement of the average U^{238} cadmium ratio of the fuel rods, of the average ratio c^* of the U^{238} capture rate to the U^{235} fission rate in fuel rods, of the distribution of resonance neutrons in the moderator, and of quantities related to the effective resonance integral of the rods. Results of the c^* and cadmium ratio measurements are presented. Resonance integrals were measured by comparing the rod cadmium ratio with cadmium ratios of Na^{23} and Mn^{55} and Co^{59}. Initial studies of a similar nature were begun on enriched U rod lattices. Intracell thermal neutron distributions and associated quantities were measured for three lattices of natural U rods in heavy water and for one lattice of partially enriched U rods in heavy water. The measured values of neutron density distributions were compared with values calculated using the THERMOS code. Good agreement was achieved for the natural uranium rods but discrepancies were noted for the enriched lattice. Use of a two-dimensional code seems likely to alleviate the discrepancies. Intracell activity distributions were obtained with bare and cadmium-covered foils of europium and lutetium to investigate the gross spectral dependence of the intracell thermal neutron distributions. Once again the distributions for natural U agreed well with THERMOS predictions while discrepancies were noted for distributions of the enriched lattices. The THERMOS code does apparently give a good estimate of the degree of spectral hardening. For natural uranium lattices disadvantage factors measured agreed well with THERMOS computations and with those calculated by the Amouyal, Benoist, and Harowitz method. Thermal utilization values obtained by the three methods also agreed. For the enriched lattice, measured and THERMOS values disagreed. Theoretical small exponential assembly research included applying age-diffusion theory to the general case of cylindrical subcritical assembly with a thermal neutron source at one end, developing correction methods for measurements of lattice parameters, and preparing tables of characteristics for a range of possible subcritical assemblies. Experimental radial flux traverses agreed well with theoretical values for the nine lattices studied, and experimental axial thermal neutron flux traverses gave reasonable agreement. Measurements of the U^{238} cadmium ratio and the calculated values of the ratio of source thermal neutron flux to the flux of lattice born and moderated neutrons showed that the lattices contained no asymptotic region. Use of small correction in the U^{238}/U^{235} fission ratio led to consistent results. Comparison of experimental intracell flux traverses with THERMOS calculations revealed good agreement only for lattices with the widest spacings. Attempts to develop a theory permitting more rapid interpretation of measured intracell flux traverses and related phenomena were made. Measurements of thermal dieaway time constants on toluene and attempts to measure slowing down times occupied part of the pulsed neutron research program. Control research involving exponential experiments with control rods and application of pulsed neutron technique to measurements of the reactivity worth of lumped neutron absorbers in subcritical assemblies was also undertaken. 31 references. (D.C.W.)

17420 (NAA-SR-7786) KINETICS, STABILITY, AND CONTROL. A Selected Bibliography. R. L. Johnson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 15, 1963. Contract AT (11-1)-Gen-8. 41p.

References to 529 articles on nuclear reactor control, kinetics, and stability published before autumn 1962 are included. Emphasis is on calculations and theory since the references serve as an aid in analyzing the dynamic behavior of SNAP reactor systems. (D.C.W.)

17421 (NAA-SR-Memo-477) A NOTE ON THE EFFECTIVE RADIUS OF CONTROL RODS. F. Fillmore (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 24, 1952. Contract [AT (11-1)-Gen-8]. 9p.

J. A. Wheeler gave a formula for the effective radius r_{eff} of an ideal absorbing rod of radius r_0 located along the axis of a hole of radius r_i in a moderating medium: $r_{eff} = r_i e^{-(4\lambda_t/3r_0)}$. It is shown that while this equation gives a value of r_{eff} that is too small, it is not a bad approximation. However, it was concluded from the statement by Wheeler that r_{eff} is increased if $r_i > r_0$ is not necessarily true. (M.C.G.)

17422 (NAA-SR-Memo-7789) FOUR GROUP CROSS SECTIONS. B. W. Colston (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Oct. 11, 1962. Contract AT-11-1-GEN-8. 14p.

At the present, 16- and 23-energy-group calculations are impractical for 2-dimensional-diffusion or transport calculation or for 1-dimensional transport survey calculations. For this reason a set of 4-group cross sections were obtained for cores with spectral characteristics similar to SNAP 2 or SNAP 8. The results of calculations using these cross sections are compared with the results using a 23-group set. The comparison is satisfactory for the values predicted for k eff and for the power distributions. The method for obtaining the cross sections is also presented and because of the ease of obtaining new sets, it is expected that many refinements in the present set and computation of new sets for cases requiring a different spectrum will be made at the discretion of the user. (auth)

17423 (NAA-SR-Memo-8088) ADDITIONAL RESULTS FROM PYROLYTIC CAPSULE FOULING TESTS. G. E.

Turney and T. T. Shimazaki (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 7, 1963. Contract [AT-11-1-GEN-8]. 12p.

Results from the Pyrolytic Capsule Fouling Tests concerning the factors which affect film formation in irradiated and unirradiated organic coolant samples on vertical and horizontal heated rods with natural convection are presented. A description of the horizontal heater PCFT facility is included. (auth)

17424 (PRDC-TR-62) MONTHLY TECHNICAL REPORT [ON APDA ACTIVITIES], AUGUST 1962. (Power Reactor Development Co., Detroit). Contract AT(11-1)-476. 14p.

Research and development progress is reported on fuels and metallurgy, engineering analysis, physics, computer programs, systems, instrumentation and electric systems, and test operations. Results of airborne dust sampling and analysis program are included. (M.C.G.)

17425 (RM-3256-PR) SOLUTIONS TO THE CRITICALITY PROBLEM FOR SPHERES AND SLABS. A. Leonard and T. W. Mullikin (RAND Corp., Santa Monica, Calif.). July 1962. Contract AF 49(638)-700. 27p. (AD-278477)

A study is presented of the problem of determining the relation between the critical size of homogeneous slab and spherical reactors and neutron production, with the assumption that the energy of neutrons is constant. Equations were derived for the slab with anisotropic scattering. The solution of these equations was studied for isotropic scattering. (auth)

17426 (TID-17385) BURNUP DETERMINATION OF NUCLEAR FUELS. Progress Report, Calendar Year 1962. J. E. Rein and B. F. Rider, eds. (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho and General Electric Co. Vallecitos Atomic Lab., Pleasanton, Calif.). Jan. 15, 1963. Contracts AT(10-1)-205 and AT(04-3)-189. 25p.

It is noted that burnup determinations are usually made to establish the energy produced by fuels and to measure the net change in fissionable isotope content of fuels. Development of methods for use in these determinations is reported. Fabrication and testing of fission counters for use in determining absolute fission yields are in progress. Other work is reported concerning supply sources for fissionable isotopes, production of higher transuranic nuclides, and fission product migration. (J.R.D.)

17427 (TID-18234) REPORT ON GOODYEAR INFLATABLE SEAL TEST FOR E.G.C.R. CHARGE MACHINE BLISTER DRIVES. (EANCO Inc., Philadelphia and Associated Testing Labs., Inc., Wayne, N. J.). Jan. 9, 1963. Contract [AT(40-1)-2014]. 15p.

Five inflatable seals were tested. Three of the seals leaked around the metal insert area when subjected to He pressure. One of the seals blew out the metal insert when subjected to He pressure, and one of the seals retained the He pressure and was cycle tested. (J.R.D.)

17428 (WCAP-1635) ORGANIC MODERATED FLUIDIZED BED REACTOR EXPERIMENT. C. C. Randall, D. R. Smith, and L. E. Strawbridge (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Nov. 30, 1960. Contract AT(30-1)-2176. 115p.

The design and cost of an organic-moderated fluidized-bed reactor experiment and associated experimental program are presented. The facility and program are based on establishing the nuclear characteristics of fluidized bed cores at powers up to 5 Mw thermal. (auth)

17429 SAFETY VIEWPOINT IN THE EQUIPPING OF REACTOR INSTALLATIONS WITH MEASUREMENT DEVICES. Atom u. Strom, 8: 83-4(Dec. 1962). (In German)

In reactors measurement devices are installed for control and operation, operational monitoring, and personnel monitoring. The considerations presented for the purpose of stimulating discussion apply only to the devices necessary to ensure safe operation of the reactor and to monitor the radiation background. (J.S.R.)

17430 EFFECT OF REFLECTORS ON THE TEMPERATURE COEFFICIENT OF REACTORS. Eberhard Kern (Technische Überwachungs-Vereine, Essen). Atomkernenergie, 8: 41-51(Feb. 1963). (In German)

Formulas for the temperature coefficients of a reactor are derived from the equations of reactor dynamics by means of a perturbation calculation. The perturbation formalism refers to an instationary boundary value problem with unsteady differential operator. The formulas derived from the one-group theory are different from the elementary formulas commonly used for the temperature coefficients. The consequences on the reactor dynamics are discussed. The results are applied to the example of a pebble-bed reactor, which is rather useful for demonstrating general laws. (auth)

17431 MEASURING POWER OF REACTOR IMPULSES BY CHERENKOV RADIATION. H. Weiss (Österreichische Hochschule, Vienna). Atomkernenergie, 8: 70-3(Feb. 1963). (In German)

The possibility of measuring power with the aid of Cherenkov radiation during an impulse was investigated. Starting from the general energy balance of nuclear fission, it was established that actually only the prompt energy proportions such as kinetic energy of the fission fragments and neutrons as well as prompt γ radiation can be conclusive in such fast transitional processes as an impulse. Since the prompt γ radiation during a pulse is proportional to the momentary power, Cherenkov radiation which is produced by way of Compton radiation and pair formation is also well suited for measuring the power. In view of the timely dissociation, the measurement with a photo cell is superior to that with an ionization chamber, due to the lower electrical time constant for very fast power changes. The considerations were confirmed experimentally by a series of measurements in which Cherenkov radiation could be measured simply and cheaply with a photo cell. (auth)

17432 INFLUENCE OF H_2O ON THE MULTIPLICATION FACTOR OF A D_2O-MODERATED NATURAL URANIUM REACTOR. H. N. Schludi. Atompraxis, 9: 24-6 (Jan. 1963). (In German)

If light water is added to the D_2O moderator of a natural uranium reactor, resonance escape probability becomes greater with the increase in the H_2O content. In addition, there is an increase in the resonance capture probability both of the neutrons of the intermediate energy group and of the neutrons of the thermal energy group. Only thermal exploitation decreases with an increase in the H_2O content. An examination of these relationships and their influence on the multiplication factor was made for various proportions of light water, moderation conditions, and fuel uses. It was found that under all technically feasible conditions, the decrease in reactivity was greater than the thermal exploitation, so that adding H_2O to a D_2O-moderated natural uranium reactor is economically inadvisable. (auth)

17433 REQUIREMENTS FOR A LOW-OUTPUT REACTOR MODEL FOR TEACHING AND RESEARCH. P. Bourgade. Atompraxis, 9: 26-32(Jan. 1963). (In French)

The criteria of selection are defined. Reactors with a very high neutron flux were eliminated for economic and operational reasons. Subcritical reactors are also ruled out because of their unsuitability for research and training work. Using a concrete example, a reactor type suitable for use in a university or research institute was chosen, assuming that about DM 800,000 are available for this purpose. The neutron-flux intensities required for various experiments, and their connection with other reactor data, were analyzed. In conclusion, construction details and physical data are given for a reactor model with an output of 10 to 100 kW, using Rebecca I as an example. (auth)

17434 CERAMIC MATERIALS CONTAINING THE RARE EARTH ELEMENTS FOR REACTORS AND FOR RADIATION PROTECTION. H. Lehmann and K. H. Mueller. Ber. Deut. Keram. Ges. V., 38: 287-93(July 1961). (In German)

The need to develop more economical high-temperature reactors with requirements of an ever-increasing standard presents a challenge to the ceramic technologist to produce materials that would be adequate for service in such reactors, viz., as fuel elements, canning materials, control rods, moderators, and radiation barriers. Owing to their high absorption cross section for thermal neutrons the rare earths (oxides of europium, samarium, and gadolinium) are very suitable for absorption rods and, since they also have a high molecular weight, for special reactor castings where, for reasons of size and weight, thinner walls are required, e.g., for mobile installations. Because of the cost of these elements, experiments are first being carried out with the cheapest, lanthanum oxide. Another reason for this choice is the chemical affinity of the latter to gadolinium oxide which is intended to replace lanthanum at a later stage. Difficulties of storing the two basic materials La_2O_3 and BaO (because of its high density BaO is also suitable for protection from γ radiation) arising as a result of their tendency to hydration can be overcome by adding acid materials. Research is also being carried out on ceramic materials containing monazite sand to develop screens against neutron and γ radiation. So far few data have been obtained on the influence of neutron bombardment on ceramic materials. (auth)

17435 OPTIMUM THERMODYNAMICAL CHARACTERISTICS OF REACTOR COOLING. Gergely Bueki. Energia Atomtech., 15: 87-93(Feb. 1962). (In Hungarian)

In order to ensure the highest degree of efficiency, in any thermal power-generating system, the heat should be transferred to the cooling agent at the highest possible temperature. In the case of a reactor, the highest permissible temperature of the fuel and its cladding represents the chief limiting factor. Correlations between the temperature distribution in the fuel channels and variations observed in the fuel elements, the cladding, and the cooling agent are reviewed for the purpose of deriving the optimum distribution for a given neutron flux. The increase of the temperature exerts an influence on the nuclear physical correlations in the system, resulting in changes not only in the specific investment cost and the thermal efficiency of the heat transfer cycle but also in the specific fuel cost because it affects the needed enrichment and thereby also the burnout. (TTT)

17436 THE PURIFICATION OF LIQUID SODIUM COOLANT FROM OXIDES AND CHECKING OF THEIR CONTENT IN A HEAT TRANSFER CYCLE. Miroslav Pašek (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Jaderna Energie, 9: 8-13(1963). (In Czech)

Discussion is given on the solution of the purity problem of the sodium coolant and on the continuous removal of oxides by filtration. The design and operation of filtration apparatus, the checking instrument, and the so-called analyzator, used for the oxide content determination in sodium and the purification of raw argon is given. The results and experience of long-term testing of the instruments and processes are also evaluated. (auth)

17437 THE ROLE OF IRRADIATION EXPERIMENTS IN A REACTOR DEVELOPMENT PROGRAMME. L. R. Shepherd (OECD, Winfrith, Eng.). Neue Tech., 4: 597-602 (Dec. 1962). (In English)

The need for extensive irradiation testing in reactor development is discussed. The various investigations in the development of a reactor system which call specifically for the use of irradiation facilities are examined with particular reference to the irradiation program of the O.E.C.D. High Temperature Reactor Project. Topics covered include: the effects of exposure of materials in a nuclear reactor, fast neutron irradiation of primary circuit steels and of graphites, in-pile mass transfer experiments, the irradiation of fuel specimens, and in-pile loop experiments. (M.C.G.)

17438 VARIOUS METHODS OF WELDING THICK-WALLED PLATES FOR ATOMIC REACTOR CONSTRUCTION. K. Winkler, F. Thyssen, and J. Mennen. Schweissen Schneiden, 14: 104-8(Mar. 1962). (In German)

Discussion is given on manual welding, submerged arc welding, and electroslag welding of thick 20 MnMo 55 steel plates of given mechanical properties. Micro- and macrostructure investigations and mechanical testing of the weldments were performed. (P.C.H.)

17439 CHEMISTRY AND METALLURGY OF PLUTONIUM. Technica, 11: 223-4(Feb. 16, 1962). (In German)

Discussion is given on the use of liquid Pu and of Zr–Pu and Al–Pu alloys as fuel in nuclear reactors and related physical, chemical, and metallurgical properties and processes including extraction of Pu and alloying with metals and nonmetals in the form of cermets or ceramics. (Rev. Metal Lit., 19: No. 5, 1962)

17440 WELDING A REACTOR VESSEL: STANDARDS DICTATED RESEARCH. Joseph F. Potochnik. Welding Engr., 47: 112; 114(Apr. 1962).

Tensile properties, Charpy impact values, hardness, ductility, and structure of seam welds in reactor pressure vessels produced by automatic submerged arc welding are presented. (Rev. Metals Lit., 19: No. 6, 1962).

17441 THE JOINT RESEARCH AND DEVELOPMENT PROGRAM QUARTERLY DIGEST, PERIOD FROM 1 JULY TO 30 SEPTEMBER 1962 Vol. 2, No. 3. (United States–Euratom Joint Research and Development Program). 74p. (TID-17947). $5.00 per yr. (Euratom)

A summary of activities in the program are presented in sections concerning contracts, scope of programs contracted during the period, and technical progress during the period. (J.R.D.)

17442 REACTOR MATERIALS. Volume 6, No. 1. R. W. Dayton, E. M. Simons, and R. W. Endebrock (Battelle Memorial Inst., Columbus, Ohio). Feb. 1963. 113p. $0.55(GPO) (Domestic), $0.70(GPO) (Foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

A review is presented of developments in fuel and fertile materials, moderator materials, nuclear poisons, cladding and structural materials, and special fabrication techniques. 390 references. Separate abstracts have been prepared for six sections of the presentation. (N.W.R.)

17443 RECENT DEVELOPMENTS IN REACTOR MATERIALS FROM POWDERS. George W. Cunningham (Battelle Memorial Inst., Columbus, Ohio). p.1-18 of "Reactor Materials. Vol. 6, No. 1."

Some of the applications of powder metallurgy to reactor-materials fabrication are reviewed. Special emphasis is given to the new techniques. Techniques discussed are powder preparation, powder rolling, vibratory compaction, plasma spraying, hot isostatic compaction, explosive compaction, electrodeposition, and procedures for producing idealized dispersions. (N.W.R.)

17444 FUEL AND FERTILE MATERIALS. p.19-51 of "Reactor Materials. Vol. 6, No. 1."

A review is presented of developments in fuel and fertile materials. Information is presented on the preparation, fabrication, properties, phase studies, and testing of the fuel materials. (N.W.R.)

17445 MODERATOR MATERIALS. p.52-62 of "Reactor Materials. Vol. 6, No. 1."

Recent developments in materials for use as reactor moderators are reviewed. Special emphasis is on the fabrication, properties, and metallurgy of graphite, beryllium, beryllium alloys, beryllium oxides, and hydrides. (N.W.R.)

17446 NUCLEAR POISONS. p.63-6 of "Reactor Materials. Vol. 6, No. 1."

Recent developments in materials for use as reactor poisons are reviewed. Phase diagrams of hafnium-vanadium and hafnium-iridium alloys are presented. Properties of boron-bearing materials, rare earth-stainless steel dispersions, rare earth compounds, and other dispersion materials are presented. (N.W.R.)

17447 CLADDING AND STRUCTURAL MATERIALS. p.67-95 of "Reactor Materials. Vol. 6, No. 1."

Recent developments in materials for use as reactor structural materials and reactor fuel element cladding are reviewed. Information is presented on corrosion, metal-water reactions, radiation effects in nonfuel materials, mechanical and metallurgical properties, diffusion, ceramic technology, and oxidation. (N.W.R.)

17448 SPECIAL FABRICATION TECHNIQUES. p.96-110 of "Reactor Materials. Vol. 6, No. 1."

Fabrication processes applicable to reactor components and materials are reviewed. Recent developments in melting, casting, heat treatment, explosive forming, cladding, nondestructive testing, and other fabrication techniques are discussed. (N.W.R.)

17449 REACTOR FUEL PROCESSING. Volume 6, No. 1. Stephen Lawroski, ed. (Argonne National Lab., Ill.). Jan. 1963. 68p. $0.55(GPO) (domestic), $0.70 (GPO) (foreign). (One of the Technical Progress Reviews prepared quarterly for the Division of Technical Information, USAEC).

A review of important developments in this area is presented. The data and other information are presented in sections on commercial aspects of fuel processing, research and development on aqueous and nonaqueous processing, waste disposal, and production of uranium. (J.R.D.)

17450 COMMERCIAL ASPECTS OF FUEL PROCESSING. p.1-5 of "Reactor Fuel Processing. Vol. 6, No. 1."

A comparison of the economics involved in operation of large fuel-processing plants is compared with small-plant operation. Data for use in comparison of various plant designs are included. Other discussion is presented concerning transportation of irradiated fuel in which cask construction and use are emphasized. (J.R.D.)

17451 RESEARCH AND DEVELOPMENT ON AQUEOUS PROCESSING. p.6-20 of "Reactor Fuel Processing. Vol. 6, No. 1."

The development status of aqueous processing techniques for reactor fuels is summarized. Included are discussions on preparation of fuel for processing, separation processes such as solvent extraction and ion exchange, process instrumentation, plant and equipment design and operation, and corrosion of construction materials. (J.R.D.)

17452 RESEARCH AND DEVELOPMENT ON NONAQUEOUS PROCESSING. p.21-43 of "Reactor Fuel Processing. Vol. 6, No. 1."

A review is presented in which development of fused-salt volatility processes, pyrometallurgical processes, and pyrochemical processes for irradiated reactor fuels are discussed. (J.R.D.)

17453 WASTE DISPOSAL. p.44-54 of "Reactor Fuel Processing. Vol. 6, No. 1."

Developments are reported on design of containers used in disposal at sea, treatment of liquid wastes by ion exchange and foam separation, conversion of high-activity wastes to solids, storage of calcined solids in salt mines, and extraction of fission products. (J.R.D.)

17454 PRODUCTION OF URANIUM, THORIUM, PLUTONIUM, AND THEIR COMPOUNDS. p.55-65 of "Reactor Fuel Processing. Vol. 6, No. 1."

Discussions are included concerning recovery of U from ores, production of UO_2, preparation of UC, and production of U metal. (J.R.D.)

17455 TEORIYA I METODY RASCHETA YADERNYKH REAKTOROV. (Theory and Calculations of Nuclear Reactors). G. I. Marchuk, ed. Moscow, Gosatomizdat, 1962. 260p.

Eighteen articles are included on various aspects of nuclear reactor theory and calculational methods. Neutron transport theory, algorithms for transport problem solution using P_2 approximation in spherical harmonics, and applications of P_2 approximation in neutron radiation protection are discussed. The spatial and angular distributions of fast neutrons in hydrogen, neutrons from point sources, two-group methods for intermediate-thermal reactors, methods for calculating absorber burnup, thermal neutron spectra in homogeneous moderator mixtures, resonance neutron capture in ring traps, and problems of mathematical and statistical treatments of nuclear physical changes are also discussed. Separate abstracts have been prepared for each article. (R.V.J.)

17456 APPLICATIONS OF SPHERICAL HARMONICS METHODS TO PROBLEMS IN TRANSPORT THEORY. GENERAL PROPERTIES OF P_n-APPROXIMATION. G. I. Marchuk and Sh. S. Nikolaishvili. p.5-24 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

General properties of P_n approximation and problems with plane and spherical isotropic sources in ideal homogeneous media are analyzed. (R.V.J.)

17457 THE METHOD OF SPHERICAL HARMONICS IN TRANSPORT THEORY. P_2-APPROXIMATION. G. I. Marchuk, Sh. S. Nikolaishvili, E. I. Pogudalina, Zh. N. Bel'skaya, and N. P. Kochubei. p.25-49 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

Numerical algorithms for neutron transport were developed by means of P_2 approximation of spherical harmonics, and data are given for the practical use of P_2 approximation in calculations for neutron radiation protection. (R.V.J.)

17458 A ONE-GROUP PROBLEM ON ANGULAR DISTRIBUTION OF NEUTRONS EMITTED BY SPHERICAL ISOTROPIC SOURCES PLACED IN THE CENTER OF A SPHERE. Sh. S. Nikolaishvili. p.50-7 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

A solution is developed for one-group integral-differential transport equations for a spherical isotropic source in the center of a homogeneous sphere. The calculations were made using the simplest square formulas and are reduced to the solution of a system of heterogeneous linear algebraic equations. Data are obtained for isotropic and anisotropic scattering inside a sphere. (R.V.J.)

17459 SPATIAL AND ANGULAR DISTRIBUTION OF SPHERICAL SOURCE NEUTRONS CONSIDERING ANISOTROPIC SCATTERING. E. E. Petrov and L. N. Usachev. p.58-71 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

Angular distributions of neutrons at various distances from the source were analyzed, and functions were found for anisotropic neutron scattering at distances shorter than the free path. Transport equations for anisotropic sources in homogeneous spherical geometry were derived using spherical harmonics for arbitrary odd P_n approximations. (R.V.J.)

17460 SPATIAL-ENERGY DISTRIBUTION OF FAST NEUTRONS IN HYDROGEN. Sh. S. Nikolaishvili. p.72-8 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

A method of moments was used for determining the spatial-energy distribution of fast neutrons in ideal hydrogen. Each integral equation for spatial-angular moments was resolved within the bounds of confluent nuclear functions. The desired function was resolved using an approximation of the first three even moments. Calculations of monoenergetic sources at 2, 4, 6, 8, 10, 12, and 14 Mev at 90 cm distance are presented. The hydrogen nuclear density is considered equal to its partial density in water. (R.V.J.)

17461 APPLICATIONS OF EFFECTIVE ONE-GROUP THEORY IN NUCLEAR REACTOR CALCULATIONS. G. I. Marchuk, V. P. Kochergin, E. I. Pogudalina, and L. I. Kuznetsova. p.79-85 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

Variations of effective one-group equations used for verifying critical parameters, considering kinetic effects, were analyzed. One-group equations were formulated for correct critical parameters and secondary neutron functions. The critical mass of spherical UO_2F_2 (90% U^{235}) with an ideal water reflector was calculated for a range of $\alpha = \rho_H/\rho_{U^{235}}$. The difference between one-group and multigroup calculations in P_3 approximation was 5%. Comparisons were made of one-group calculations for uranium–graphite systems with a wide range of $\rho_C/\rho_{U^{235}}$. The one-group solutions in P_1 approximation with variable radius constants were in good agreement with multi-group equations in the same approximation. (R.V.J.)

17462 EFFECTIVE TWO-GROUP CALCULATIONS FOR INTERMEDIATE-THERMAL REACTORS. S. B. Shikov and V. B. Troyanskii. p.86-90 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

One-group calculations of fast reactor critical masses are shown, in the absence of extraneous effects, to give highly accurate results. However, in therma. and intermediate-thermal systems the extraneous effects are higher than one-group calculations indicate. A two-group method with averaged constants in the epithermal group, similar to averaging used in one-group calculations, is suggested. The developed system considers the effects of scattering in hydrogen, inelastic scattering by heavy nuclei, U^{235} fission at all energies, fast fission of U^{238}, blocking of U^{238} and U^{235} resonances, and effects of heterogeneity. The numerical results showed the analogy of effective two-group calculations to spatial multi-group calculations. (R.V.J.)

17463 SOLUTIONS FOR KINETIC EQUATIONS DEVELOPED BY S_n METHOD. V. N. Morozov. p.91-117 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

The general formulation for resolving neutron transport equations by the S_n method was discussed. Numerical algorithms were realized, and an improved convergence of numerical approximations was found. Two methods were given for reducing the number of iterations. The S_n solutions for one-group problems in spatial and angular distribution in one-dimensional, spherical, and cylindrical geometries are described. Numerical calculations illustrate the efficiency of the method for reducing the iterations. (R.V.J.)

17464 CALCULATIONS OF FUEL BURNUP IN REACTORS. G. I. Toshinskii and A. G. Kalashnikov. p.118-43 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

A method is suggested for calculating fuel burnup in intermediate and thermal reactors. The maximum reactivity imbalance resulting from incompatibility between absorber and fuel burnup, thus dictating control rod and fuel loading schedules, is also within the scope of the method. (R.V.J.)

17465 SPECTRUM OF THERMAL NEUTRONS IN HOMOGENEOUS MODERATOR MIXTURE WITH VARIABLE TEMPERATURE. M. S. Yudkevich. p.144-54 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

Thermalization of neutrons in homogeneous moderators at various temperatures was analyzed, assuming a gaseous moderator model. The moderator consists of heavy nuclei and hydrogen. Neutron scattering from free nuclei is considered to be Maxwellian. (R.V.J.)

17466 MONTE CARLO METHOD FOR CALCULATING ENERGY AND ANGULAR DISTRIBUTIONS OF γ QUANTA PASSING THROUGH A PLANE-PARALLEL LAYER OF FINITE THICKNESS. S. M. Ermakov, V. G. Zolotukhin, and V. A. Kom'shin. p.155-9 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

The Monte-Carlo method was employed for determining the shielding for 0.5, 1.25, and 7-Mev γ quanta incident at 0, 15, 60, 75, and 90° calculated to the normal of 10, 15, and 25-cm thick polyethylene plates. (R.V.J.)

17467 CALCULATION OF RESONANCE ABSORPTION OF NEUTRONS IN HOMOGENEOUS MEDIA. F. F. Mikhailus. p.160-78 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

A direct numerical solution was obtained for neutron resonance absorption in homogeneous media. A systematic evaluation was made of potential and resonance scattering interference, Doppler broadening, and superposition of adjacent resonances without making any assumption for the relative width of the critical zone and the distance between levels. (R.V.J.)

17468 EFFECTS OF THE INTERFERENCE OF POTENTIAL AND RESONANCE SCATTERING ON THE RESONANCE ABSORPTION OF NEUTRONS IN A SUBSTANCE.

A. A. Lukyanov and V. V. Orlov. p.179-90 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

An integral equation was formulated for the mean neutron flux in a slab, and resonance integrals were calculated considering interferences in infinite and finite homogeneous media. A numerical estimate was made for Fe^{56} resonance and I_{eff} at E = 28 kev. (R.V.J.)

17469 RESONANCE CAPTURE OF NEUTRONS IN AN ANNULAR TRAP. G. I. Marchuk and V. P. Il'in. p.191-9 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

The effective resonance integral in an annular trap was calculated considering mutual neutron screening. The initial data are based on the Orlov-Rudikov formula effective for arbitrary slab thicknesses. (R.V.J.)

17470 CONSTRUCTION OF MULTIGROUP RESONANCE CONSTANTS CONSIDERING HETEROGENEOUS EFFECTS. S. B. Shikhov and L. P. Abagyan. p.200-22 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

The multigroup constants for heterogeneous systems were employed in calculating multigroup cross sections for a resonance energy region considering the isotopic content and lattice parameters. The effective integral level system demanded a comparatively smaller number of groups. Resonance integrals for > 10 kev groups are tabulated for Th^{232}, U^{233}, U^{235}, U^{238}, Pu^{239}, Pu^{240}, Pu^{241}, and for U^{235} fragment pairs. (R.V.J.)

17471 MATHEMATICAL-STATISTICAL TREATMENT OF NUCLEAR-PHYSICAL MEASUREMENTS. V. G. Zolotukhin. p.223-43 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

Statistical treatments of nuclear-physical measurements are analyzed. The maximum probability method and the method of least squares are discussed, and radioactive decay constants are determined. The method of functions is employed in an analysis of neutron resonance parameters. (R.V.J.)

17472 CALCULATIONS OF TRANSPORT CROSS SECTIONS USING OPTICAL MODEL. V. E. Kolesov. p.244-53 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

An optical model was employed in experimental measurements of transport cross sections, σ_{tr}. The transport cross sections were determined using experimental differential cross sections of elastically scattered neutrons $\sigma_{n\mu}$ (where μ is the cosine of the angle of scattering in laboratory coordinates). The results showed that neutron scatterings vary with energy. However, differential cross sections, as functions of neutron energy and nuclear atomic weight, possess smooth systematic properties indicating that they do not depend on the intrinsic structure of nuclei but are functions of general nuclear properties. Hence, it is considered feasible to describe the angular distribution and transport cross sections using an optical model of nuclear interactions. (R.V.J.)

17473 INELASTIC NEUTRON SCATTERING ON Fe NUCLEI. D. L. Broder, A. I. Leshuk, I. P. Sadokhin, and A. P. Suvorov. p.254-9 of "Teoriya i Metody Rascheta Yadernykh Reaktorov." Moscow, Gosatomizdat, 1962.

Total cross sections of inelastic neutron scattering on iron and differential cross sections of the separate levels were measured at 0.80 to 4.0 Mev. The γ spectra formed, using 0.80 to 2.5 Mev neutrons from $T^3(p,n)He^3$ reactions and 2.5 to 4-Mev neutrons from $D(d,n)He^3$ reactions, were measured. The γ yield in inelastic 4-Mev neutron scattering was E_γ = 0.84, 1.02, 1.23, 1.44, 1.81, 2.15, and 2.6 Mev. An analysis of Fe^{56} and Fe^{54} decay schemes showed all γ lines, except E_γ = 1.41 Mev, were produced by inelastic scattering. Total cross sections of inelastic scattering from natural isotopic mixtures are proportional to the total yields of 1.41 and 0.84 Mev γ quanta. (R.V.J.)

17474 IMPROVEMENTS IN OR RELATING TO HEAT EXCHANGERS. Frank Williams and Colin Frederick Price (to Central Electricity Generating Board). British Patent 917,278. Jan. 30, 1963. Filed Aug. 5, 1959.

A multi-finned polyzonal heat exchanger is designed which is especially suited for use as a fuel element in gas-cooled reactors. The heat exchanger comprises an outer sleeve, a central member with helical fins located inside the sleeve, and a number of vanes secured to the sleeve and extending radially to the central member. Thus, the vanes form gas-tight seals between the zones between the vanes at their outer edges, and the pressure drop across the heat exchanger is reduced in comparison with other heat exchangers having a loose fit between the vanes and the sleeve. (D.L.C.)

17475 METHOD OF OBTAINING A UNIFORM OUTPUT DENSITY IN GAS-COOLED HIGH-TEMPERATURE NUCLEAR REACTORS. (to Brown, Boveri and Cie, Aktiengesellschaft). British Patent 918,907. Feb. 20, 1963. Priority date Mar. 4, 1961, Germany.

A means to equalize the neutron density in the core of a gas-cooled reactor operated with a mound of uniformly shaped bodies is provided. Shaped bodies of different materials are fed to the reactor core through a feed duct so that they are introduced in dependence upon the angle of slope of the mound. The materials are fuel elements, breeder-material elements, and moderator elements. The fission cross section of fuel elements is large and decreases slowly during consumption. For breeder material elements the fission cross section is at first nil and increases in proportion to the breeding effect. In the moderator elements the fission cross section is nil. (C.E.S.)

17476 DRIVE MEANS FOR CONTROL MEMBERS IN NUCLEAR REACTORS. (to Siemens Schuckertwerke Aktiengesellschaft). British Patent 919,171. Feb. 20, 1963. Priority date Feb. 17, 1959, Germany.

A drive system for reactor control rods is provided in which the advantages of the hydraulic form of drive are combined with those of the magnetic jack; so that a powerful, robust, electro-hydraulic drive is created. This permits sensitive control of the rod without the use of precision parts. (C.E.S.)

17477 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Vincent Walker (to United Kingdom Atomic Energy Authority). British Patent 919,191. Feb. 20, 1963. Filed June 26, 1959.

A reactor fuel element composed of a ceramic fuel member with an adherent coating of nonfissile metallic material and enclosed in a protective sheath is provided. Heat transfer from the ceramic fuel member is improved because there is a larger area of contact between the member and the coating deposited in the surface pores of the member than between the member and the sheath. Heat transfer to the sheath is improved because of the greater thermal conductivity of the metal coating. (C.E.S.)

17478 A GLASS PRODUCT. (to Compagnie de Saint-Gobain). British Patent 919,810. Feb. 27, 1963. Priority date Dec. 30, 1958, France.

A glass product is provided that has a high uranium and/

or thorium content, is substantially free from any element having a large neutron-capture cross section, and is capable of being made into particles or microbeads. The particles are only slightly attacked by heavy water at a temperature of 300°C. (C.E.S.)

17479 IMPROVEMENTS IN OR RELATING TO FLUID NUCLEAR REACTORS. Stefan George Bauer and Norman Battle (to Rolls-Royce Ltd.). British Patent 919,822. Feb. 27, 1963. Filed Aug. 6, 1958.

A nuclear reactor is provided that has fuel elements housed in tubular fuel channels in which coolant flows. The fuel channels are provided with internal baffles forming coolant paths suitably shaped to prevent radiation from the fuel elements leaving the fuel channels. (C.E.S.)

17480 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR SERVICING MACHINES. Donald Alfred French (to General Electric Co. Ltd.). British Patent 919,866. Feb. 27, 1963. Filed Sept. 2, 1960.

A nuclear reactor servicing machine is provided with an improved stowage means for control rod assemblies. (C.E.S.)

17481 IMPROVEMENTS IN OR RELATING TO SPACING ARRANGEMENTS FOR NUCLEAR FUEL ELEMENTS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 919,986. Feb. 27, 1963. Priority date May 23, 1959, Germany.

A nuclear fuel element is described that is composed of a plurality of fuel rods. The fuel rods are disposed in straight or circular rolls and are separated by means of corrugated metal straps. (C.E.S.)

17482 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. Harold Kenyon Hardy (to United Kingdom Atomic Energy Authority). British Patent 920,167. Mar. 6, 1963. Filed Feb. 16, 1960.

A reactor fuel element is described that is made up of a fissile member having a hollow core, enclosed in a protective sheath. An insert of breeder material partially fills the hollow core, leaving cavities to accomodate growth of the fissile member under irradiation. Means is provided to close off the hollow core in the event of coolant leakage through the sheath. (C.E.S.)

17483 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENT ARRANGEMENTS. Keith James Mitchell and Bernard Hugh Stonehouse (to General Electric Co. Ltd.). British Patent 920,200. Mar. 6, 1963. Filed Dec. 18, 1958.

A method for reactor fuel element arrangement is described that eliminates the need for a fuel element thermocouple with long trailing leads. The temperature within the fuel element channels can be determined by contacts within the channels. (C.E.S.)

17484 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. Maurice Avramito and Rene Cebelieu (to Commissariat à l'Énergie Atomique). British Patent 920,256. Mar. 6, 1963. Priority date June 5, 1958, France.

A fuel element is described that is adapted so as to dissipate the heat generated by fission. The perimeter of the cross section of the can varies along its length, in a continuous or discontinuous manner, in such a way that the temperature of the can remains close to the maximum permissable value at all of its points. (C.E.S.)

17485 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Ronald Wildgoose (to Rolls-Royce Ltd.). British Patent 920,274. Mar. 6, 1963. Filed Nov. 21, 1959.

An electric circuit is described that indicates the position of a movable control rod relative to the control rod column. (C.E.S.)

17486 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENT ASSEMBLY FOR NUCLEAR REACTORS. (to Babcock and Wilcox Co.). British Patent 920,343. Mar. 6, 1963. Priority date Apr. 30, 1959, United States.

A fuel pin bundle is provided for use in a reactor. Means are provided for locating the pins in the bundle relative to one another, and spacers are provided to align each of the outer fuel pins with an adjacent outer fuel pin. The outer fuel pins have a lower fissionable material content, to avoid power peaking. (C.E.S.)

17487 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Herbert Chilvers Knights (to United Kingdom Atomic Energy Authority). British Patent 920,531. Mar. 6, 1963. Filed Feb. 4, 1958.

A combination containment vessel for a moderator-reflector structure of a graphite moderated reactor and restraint band for the structure are described. The restraint mechanism is particularly suited for a reactor built into a moving body such as a ship. (C.E.S.)

17488 IMPROVEMENTS RELATING TO NUCLEAR REACTOR CORE. Francis Robert Bell (to De Havilland Engine Co. Ltd.). British Patent 920,576. Mar. 6, 1963. Filed Mar. 16, 1959.

A nuclear reactor core composed of a number of stacked horizontal layers is described. Each layer is made up of elements of moderator material of equal height and of generally hexagonal cross-section. Each element has holes containing nuclear fuel and separate ones for coolant. (C.E.S.)

17489 NUCLEAR REACTOR CORE. George Edward Preece, Francis Robert Bell, and Robert William Page (to De Havilland Engine Co. Ltd.). British Patent 920,577. Mar. 6, 1963. Filed June 1, 1959.

A nuclear reactor core is described. It contains fuel in the form of blocks or pellets that have a grooved, wrinkled, or corrugated surface to provide a greater radiating surface area. The surfaces of spaces in the core are correspondingly corrugated for maximum heat exchange area. (C.E.S.)

17490 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR SERVICING MACHINES. Robert Andrew Wright (to General Electric Co., Ltd.). British Patent 920,847. Mar. 13, 1963. Filed Nov. 18, 1960.

A servicing mechanism for a gas-cooled reactor is designed with an improved indexing mechanism for the charge chute. The indexing mechanism comprises an indexing head engaged by the inner end of the chute, and a reciprocating assembly carrying a pawl for engaging the head. During each forward stroke of the assembly, the charge chute is rotated from one indexing position to the next indexing position. (D.L.C.)

17491 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Andre Huet. British Patent 921,288. Mar. 20, 1963. Priority date, July 9, 1958, France.

A reactor is described whose fuel comprises sheathed spheres with spikes distributed over their surfaces for maintaining the spheres in spaced relationship with each other. The spiked fuel spheres are heaped in cylindrical baskets which are mounted in the reactor on devices enabling the distances between the baskets to be altered for control of the reactor cavity. Further control may also be effected by varying the flow rate of the coolant which may contain a neutron absorber, moderator material, or fissile material. (D.L.C.)

17492 IMPROVEMENTS IN OR RELATING TO SERVICING MECHANISMS FOR FLUID-COOLED NUCLEAR REACTORS. Colin Taylor (to General Electric Co., Ltd.). British Patent 921,348. Mar. 20, 1963. Filed Jan. 4, 1961.

A modified servicing mechanism of the type described in British Patent 916,980 is designed for use in reactors of the type described in British Patent 878,506. The mechanism has a rotatable charge tube with an articulated radial end and is provided with an indexing member with retractable stop means in order to operate in any one of a number of radially aligned channels. (D.L.C.)

17493 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Ernest Smith (to United Kingdom Atomic Energy Authority). British Patent 921,434. Mar. 20, 1963. Filed June 9, 1960.

A protective sheath with fins is designed which is relatively easy and cheap to fabricate and which gives efficient heat transfer without high coolant pressure drop. The sheath has longitudinal splitter fins and longitudinal heat transfer fins located between the splitter fins. Both the splitter and heat transfer fins are corrugated and can be made easily by extrusion. (D.L.C.)

17494 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Stefan George Bauer and Norman Battle (to Rolls-Royce Ltd.). British Patent 921,447. Mar. 20, 1963. Filed Nov. 2, 1959.

A reactor control system is designed which effects control by varying the level of an absorber or moderator liquid in the reactor. The system comprises tubes in the reactor, a device for indicating the liquid level in the tubes, and means for varying the liquid level. (D.L.C.)

17495 IMPROVEMENTS IN AND RELATING TO ACTUATING MECHANISMS FOR NUCLEAR REACTOR CONTROL RODS AND THE LIKE. Douglas Oliver Hanson (to Nuclear Power Plant Co., Ltd.). British Patent 921,660. Mar. 20, 1963. Filed June 2, 1960.

An actuating mechanism of the chain-drum type is designed for reactor control rods. The mechanism comprises a driven pulley wheel located in a reactor standpipe, and a chain passing over the wheel so that rotation of the wheel causes one end of the cain to be raised and the other end to be lowered into the reactor. A control rod is suspended from one end of the chain. When the control rod is withdrawn from the reactor, the radioactivity of the raised chain is not cumulative as would be the case if the chain was wound in turns around the wheel. (D.L.C.)

17496 RESTRAINING MEANS. (to Babcock and Wilcox Ltd.). British Patent 921,699. Mar. 20, 1963. Priority date, Jan. 19, 1961, Germany.

A restraint garter is designed for the core of gas-cooled, graphite-moderated reactor. The garter comprises an inextensible ring, a series of head members, and a corresponding series of displaceable members. The head members are adapted to act through the displaceable member to support the ring. (D.L.C.)

17497 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Siemens-Schuckertwerke A. G.). British Patent 921,710. Mar. 20, 1963. Priority date, July 12, 1958, Germany.

A fuel element is designed for use at high temperatures. The fuel element comprises one or more shaped bodies of heat-resistant fuel (e.g., UC_2–graphite) disposed within a casing in such a way that the bodies are supported out of contact with the casing by holders made of graphite or a ceramic material and fixed in position by metallic centering members. Thus, no reactions can occur between the fuel and the casing, and the fuel does not limit the upper working temperature of the coolant. (D.L.C.)

17498 IMPROVEMENTS IN OR RELATING TO ELECTRIC CONTROL OR MONITORING EQUIPMENT OR APPARATUS. Pranab Rebatiranjan Dastidar (to E. K. Cole Ltd.). British Patent 921,774. Mar. 20, 1963. Filed Apr. 10, 1959.

A monitoring means is designed for a fail-safe reactor control or indication circuit. The monitoring means comprises means for deriving an electrical signal from an apparatus being monitored, means for impressing the signal on a transistor circuit constituting a trip circuit for a relay, means for impressing a train of narrow pulses on the trip circuit, and means for operating the relay in the absence of the pulses to simulate the effect of unwanted changes in the electrical signal. (D.L.C.)

17499 LIQUID MODERATOR NUCLEAR REACTORS SUBJECT TO VARYING MOVEMENTS. Pierre-Jean Ricard, Alfred Hirtz, and Michel Clayer (to Commissariat à l'Énergie Atomique). Canadian Patent 649,259. Sept. 25, 1962. Priority date Aug. 22, 1958, France.

A flow control means is adopted to regulate the delivery of moderator to the reactor vessel as a function of acceleration of the reactor upon movement. The variation of the density of the liquid in the vessel is reduced by the flow control, which increases the delivery upon reduction of density and reduces delivery upon increase of density. (C.E.S.)

17500 NUCLEAR REACTOR WITH FUEL UNDER SPHEROIDAL FORM. André Huet. Canadian Patent 650,296. Oct. 16, 1962. Filed Aug. 14, 1959.

The fissible material for a reactor is provided in the form of small spheres contained in a jacket having thin walls that are permeable to neutrons. A system of fins on the outside of each sphere allows appropriate spacing. The central portion of the sphere is hollow and eventually forms a neutron reflector. (C.E.S.)

17501 GAS COOLED ATOMIC REACTOR. Ragnar Liljeblad (to Allmänna Svenska Elektriska Aktiebolaget). Canadian Patent 652,867. Nov. 27, 1962. Priority date Nov. 29, 1954, Sweden.

A device for holding the gas collection and distribution vessel bottoms and covers in spaced relation to the reactor gas tube outlets and to each other consists of discs with spaced holes bolted to the vessels. A ring formed from slit, flanged tubing provides tightening between the reactor tank and the vessels, and the bottom of the collector vessel joins the wall through two sheet rings externally welded together and internally welded to the vessel and wall. (D.C.W.)

17502 THERMAL EXCHANGE OF THE FUEL ELEMENTS IN NUCLEAR REACTORS. Jean Le Foll (to Commissariat à l'Énergie Atomique). Canadian Patent 653,172. Nov. 27, 1962. Priority date Aug. 13, 1959, and Apr. 6, 1960, France.

Thermal exchange between fuel elements and the surrounding fluid is improved by fitting the fuel element casing with transverse fins over which a cover with inlet and outlet orifices (some having inclined blades) is placed. (D.C.W.)

17503 NEUTRONIC REACTOR AND FUEL ELEMENT THEREFOR. Karl H. Hoecker (to Siemens-Schuckertwerke Aktiengesellschaft). Canadian Patent 653,910. Dec. 11, 1962. Priority date July 12, 1958, Germany.

A fuel assembly for a neutronic reactor in which most of the heat is transmitted to the coolant by thermal radiation consists of a tubular member, the fuel element being suspended symmetrically therein. The assembly is concentri-

cally aligned in a reactor channel with coolant flowing between the channel wall and the assembly. (D.C.W.)

17504 NUCLEAR REACTOR SUPPORT HOUSING FOR FUEL ELEMENTS HAVING PARALLEL RODS AND EXTERNAL ARMATURE. Roland Roche and Bernard Vrillon (to Commissariat à l'Énergie Atomique). Canadian Patent 654,762. Dec. 25, 1962. Priority date Mar. 16, 1959, France.

Fuel rods are supported parallel to each other by a housing (cylindrical block) with many compartments regularly distributed around its axis and with low neutron absorption. Detachable abutments engage the block and hold the rods in symmetry in their compartments. (D.C.W.)

17505 STRUCTURE OF A CASING COMPRISING A CYLINDRICAL BODY WITH HELICAL FINS. (to Commissariat à l'Énergie Atomique). French Patent 1,218,482. Jan. 15, 1962. Filed Mar. 17, 1960.

In a first embodiment the fuel element casing comprises a cylindrical body with sets of portions of helical parallel fins having substantially a longitudinal direction. Narrow longitudinal as well as transversal passages without fins are provided between adjacent sets, the direction of the helices in each set being opposite to that in each adjacent set. In a second embodiment the sets form circumferential bands separated by transversal passages, the direction of the helices in each band being opposite to that in the adjacent bands. (NPO)

17506 IMPROVEMENTS IN FUEL ELEMENTS FOR NUCLEAR REACTORS. (to C. A. Parsons and Co. Ltd.). French Patent 1,231,675. Apr. 19, 1960. Priority date Nov. 19, 1957, Great Britain.

The patent describes a rod-type fuel element with helical fins, which are interrupted by longitudinal baffles, bracing and locking means being provided to restrict radial, circumferential, and axial movements of said baffles. (NPO)

17507 IMPROVEMENTS IN METHODS OF OPERATING NUCLEAR REACTOR ELEMENTS. (to S. A. d'Etudes et Réalisations Nucléaires Sodern). French Patent 1,238,281. Oct. 30, 1961. Filed Feb. 26, 1960.

The patent relates to a nuclear reactor in which fuel elements are applied, the canning of which transmits infrared radiation. The core of the reactor is provided with a honeycomb structure in the cells of which the fuel elements are mounted, the walls of the structure being corrugated and being covered with a material that absorbs infrared radiation. (NPO)

17508 ARRANGEMENT FOR ELIMINATING RADIOACTIVE IMPURITIES FROM THE GAS COOLANT CIRCUIT OF A NUCLEAR REACTOR. (to Brown, Boveri & Cie, A.G. and Beteiligungs- und Patentverwaltungsgesellschaft m.b.H). French Patent 1,261,526. Apr. 10, 1961. Priority date Aug. 27, 1959, Germany.

The purification circuit for the gaseous coolant of a nuclear reactor contains a strongly cooled adsorption filter which is preceded by an analogous filter, operating at a higher temperature. The dimensions of the latter are such that the greater part of the radioactive impurities decompose during their passage through the filter. (NPO)

17509 FUEL ELEMENTS FOR NUCLEAR REACTORS AND MEANS FOR THEIR FIXATION. (to United Kingdom Atomic Energy Authority). French Patent 1,281,809. Dec. 4, 1961. Priority date, Mar. 2, 1960, Great Britain.

The patent comprises a lateral support means for fuel rods of the well-known spider type, one of its legs being provided with a radially extensible part which is pressed against the channel wall under the action of a spring. The support prevents vibration of the rod. (NPO)

17510 METHOD AND MEANS FOR MONITORING THE POWER DISTRIBUTION THROUGHOUT A NUCLEAR CHAIN REACTOR. Samuel Untermyer (to General Electric Co.). German Patent DAS 1,128,057. Apr. 19, 1962. Filed Jan. 29, 1960.

A method is given for monitoring the power distribution throughout a nuclear chain reacting assembly disposed in a reactor vessel and having a plurality of nuclear fuel containing coolant flow channels through which a liquid coolant is passed. The method comprises the steps of collimating the penetrating radiation emitted from at least one of the given flow channels and measuring the intensity of the collimated radiation at points remote from the assembly and outside the vessel. The means for putting into action the above method consist of a radiation detecting system outside the core and the reactor vessel and a radiation collimator between the reactor core and the detecting system, in which the collimator includes an elongated external collimating element, which is placed immediately adjacent to the detecting system, and an elongated internal collimating element, which is placed inside the reactor vessel adjacent to the core. (Gmelin Institute)

17511 SAFETY DEVICE FOR NUCLEAR REACTORS. Herbert Machnig (to Beteiligungs- und Patentverwaltungsgesellschaft Mit Beschrankter Haftung and Brown, Boveri & Cie., A.G.). German Patent DAS 1,139,216. Nov. 8, 1962. Filed Apr. 28, 1961.

A safety device is provided for nuclear reactors which communicate with a storage tank from which gas is supplied into the reactor. As the gas in the nuclear reactor is under the action of activating nuclear radiation, care has to be taken that in case of a leakage in the storage tank no radioactive gas from the reactor is flowing back to the tank. This is achieved by designing the connecting pipes between the tank and the reactor in such a way that the delay time of the passing gas in the pipes can be controlled. As long as the pressure in the storage tank is higher than the pressure in the reactor, the resistance for the gas flow is at a minimum. But when the pressure in the storage tank is lower than the reactor pressure, the gas flow is delayed so that the radioactivity of the gas entering the storage has declined to an acceptable value. (Gmelin Institute)

17512 LEADING-IN PLATE FOR PASSING CABLES INTO A REACTOR VESSEL. Hans-Guenter Hagen and Wolfgang Roessner (to Siemens-Schuckertwerke A.G.). German Patent DAS 1,139,217. Nov. 8, 1962. Filed Mar. 8, 1961.

A perforated plate is given for passing cables, e.g., thermoelement cables, into a reactor vessel. The bores of this plate are provided with conically shaped collars on at least one side of the plate. The collars have the same inside diameter as the bores extending them outward from the plane of the plate. Members are pressed on each of these collars, which have either a conical or a cylindrical internal bore. The dimensions of the internal bore of the members are of a size that though the cable passes loosely through them, the inside diameter of the collars is reduced when the members are pressed on them. The collars are thus pressed on to the sheath of the cable rendering a leaktight seal. The members can be suitably shaped counter plates or single rings. (Gmelin Institute)

17513 DEVICE FOR MONITORING AN INSULATING TUBE WHICH IS LOCATED INSIDE A PRESSURE TUBE OF A NUCLEAR REACTOR. Hans-Peter Schabert (to Siemens-Schuckertwerke A.G.). German Patent DAS 1,141,391. Dec. 20, 1962. Filed Nov. 3, 1960.

A device for monitoring an insulating tube which is lo-

cated inside a pressure tube of a nuclear reactor, especially a nuclear reactor moderated by heavy water, is described. Between the insulating tube and the pressure tube, a ring-shaped space is formed which is normally filled with a stagnant coolant medium. In case of failure of the insulating tube a certain amount of coolant flow is established in this space raising the temperature of the pressure tube wall. Therefore a temperature measuring device is located within the wall of the pressure tube for registering a predetermined temperature rise. (Gmelin Institute)

17514 DEVICE FOR PRESSURE SUPPRESSION VAPOR CONTAINMENT. Heinz Kornbichler (to Licentia Patent-Verwaltungs-G.m.b.H.). German Patent DAS 1,142,041. Jan. 3, 1963. Filed Nov. 24, 1959.

The basic concept of the device described involves quenching of the steam issuing from a break in the primary reactor system in a water pool. The nuclear reactor and primary coolant system are completely contained in a vapor-tight pressure vessel. The inside of the pressure vessel is subdivided by a perforated horizontal partition-wall, the holes of which are normally sealed by diaphragms. The reactor and its primary coolant system are located in the lower part of the pressure vessel, which is dry. On the horizontal partition-wall in the upper part of the pressure vessel there is a pool of cold water. In the event of a primary system rupture, water and steam will discharge into the lower part of the pressure vessel. The resulting pressure in this part of the vessel will disrupt the diaphragms and the steam will flow through the holes into the pool. (Gmelin Institute)

17515 SAFETY RELEASE MECHANISM FOR NUCLEAR REACTORS. Stephen Baldwin Dunwich Fletcher and Deric Birkenshaw (to Nuclear Power Plant Co. Ltd.). German Patent DAS 1,142,423. Jan. 17, 1963. Priority date Sept. 8, 1958, Great Britain.

A safety release mechanism is described which under certain faulty conditions in nuclear reactors causes the disengagement of a safety element (rod) from its holding device. The mechanism consists of a pressure or temperature sensitive device, which is connected rigidly with the safety element and which is responsive to pressure or temperature changes in the fluid in which the safety element is immersed. If a predetermined pressure or temperature change occurs, the sensitive device exerts a force on a system of push rods sufficient to trip a standard type latch mechanism which joins the element and the holding device. The sensitive device comprises a bellows connected to a piston forming an enclosed space. An orifice in the piston facilitates communication between the inside of the bellows and the surrounding fluid. The piston being in contact with the push rods, any extension of the bellows will cause the disengagement of the safety element. (Gmelin Institute)

17516 MECHANICAL DEVICE FOR MOVING REACTOR CONTROL AND SAFETY RODS IN NUCLEAR REACTORS. Anatole Dmitrieff (to Commissariat à l'Énergie Atomique). German Patent DAS 1,142,972. Jan. 31, 1963. Priority date Mar. 28, 1960, France.

The mechanical device consists of a thimble-like extension tube that is flanged to the reactor vessel, a rack and pinion drive unit within the extension tube that is geared to a motor outside the tube, and a shaft that is rigidly but demountably attached to the control rod and to the rack of the unit. The shaft is shaped in such a way that when moving the rod in one of its two extreme positions, the opening of the reactor vessel is sealed. In order to prevent contamination of the thimble and the drive unit with fission products it is proposed to establish a continuous flow of reactor coolant between the two head sides of the thimble and through the annulus formed between the rack and the shaft for one thing and the thimble for another, the flow being directed to the opening in the reactor vessel. (Gmelin Institute)

17517 METHOD FOR AUTOMATICALLY STARTING A NUCLEAR REACTOR FROM SUBCRITICALITY. Pavel Kovanic and Milan Kulka (to Zavody V. I. Lenina). German Patent DAS 1,143,278. Feb. 7, 1963. Priority date Feb. 18, 1958, CSR.

The method described comprises the moving of a sufficiently sensitive detector, according to a program, on a path along which the radiation intensity has an exponential dependence of the space coordinate. The detector signal is compared with another fixed signal, and the output signal is fed from the comparator into the drive mechanism of the control elements which are then moved according to the value of that signal. When the chosen reactor power is reached, the movement of the detector is stopped. (Gmelin Institute)

17518 NUCLEAR REACTORS. Alan Robert Kirkpatrick (to C. A. Parsons and Co. Ltd.). U. S. Patent 3,074,872. Jan. 22, 1963. Priority date Dec. 4, 1956, Great Britain.

A fuel-loading device for graphite-moderated reactors is patented. The device consists of a set of fixed tubes passing through the shell of the reactor and axially aligned with fuel channels in the core. Within the core, each tube has a movable part which can be aligned with other fuel channels within a defined radius. The channels outside the sweep of the movable tube are used for control rods. The fixed tubes and the fuel channels are arranged in a specified geometry so that a maximum number of fuel channels can be loaded with a minimum number of tubes penetrating the reactor shell. Control rods which are movable in and out of the core are also patented. (M.P.G.)

17519 NUCLEAR REACTOR FUEL ELEMENT COMPRISING A PLURALITY OF CONCENTRIC CYLINDERS. Harry P. Kling and Edward Meyer (to Sylvania Electric Products Inc.). U. S. Patent 3,074,873. Jan. 22, 1963. Filed Feb. 6, 1958.

A type of fuel structure was patented, which can be easily assembled and does not require welding. The fuel element is constructed from a plurality of cylindrical sections with serrated edges, which are dovetailed to adjacent edges to form concentric cylinders and then secured by pins in a specified manner. Each section is composed of a radioactive core with a continuous outer coating of a suitable metal such as Al. This type of fuel structure can be used to form polygons or other shapes as well as cylinders. Methods for joining the fuel sections are described in detail. (M.P.G.)

17520 NUCLEAR REACTORS. Michel Grenon, Louis Berthod, Georges Cohen de Lara, Michel Delachanal, and Georges Halbronn (to Commissariat a l'Energie Atomique). U. S. Patent 3,074,874. Jan. 22, 1963. Priority date May 10, 1957, France.

A method for rapidly withdrawing vapor from a boiling-liquid homogeneous reactor is patented. The active fluid in the core of the reactor is made to circulate by providing an inflow of fluid, which is tangential to the periphery of the core. The vortex movement of the core fluid drives the vapor bubbles toward the center, where a funnel is formed, from which the vapor can flow out at high speed. Various core-vessel designs utilizing this principle of vapor withdrawal are described in detail. (M.P.G.)

17521 NUCLEAR REACTORS. Anthony J. Taylor (to Babcock and Wilcox Ltd.). U. S. Patent 3,075,910. Jan. 29, 1963. Priority date Aug. 22, 1957, Great Britain.

A means for positioning fuel elements in a fluid-cooled nuclear reactor is described. The reactor core contains vertical smooth-walled fuel channels with withdrawable fuel elements resting one upon the other within the channel. The positioning means consists of a plurality of wedges distributed around the lower end of a fuel element and a boss on the upper end which comes in contact with the wedges on the adjacent fuel element, forcing them outward, thereby positioning and securing the fuel elements in the channel. This invention is particularly suitable for naval reactors, where the reactors are subjected to pitching and rolling. (M.P.G.)

17522 NUCLEAR REACTOR CORE. Francis Robert Bell (to De Havilland Engine Co. Ltd.). U. S. Patent 3,076,753. Feb. 5, 1963. Priority date Mar. 16, 1959, Great Britain.

A nuclear reactor core composed of a number of identical elements of solid moderator material fitted together was designed. Each moderator element is apertured to provide channels for fuel and coolant. The elements have an external shape which permits them to be stacked in layers with similar elements, with the surfaces of adjacent elements fitting and in contact with each other. The cross section of the element is of a general hexagonal shape with identations and protrusions, so that the elements can be fitted together. The described core should not be liable to fracture under transverse loading. Specific arrangements of moderator elements and fuel and coolant apertures are described. (M.P.G.)

17523 NEUTRONIC REACTOR FUEL HANDLING SYSTEM. Robert G. McGrath, Walter P. Haass, and William A. Frederick (to Westinghouse Electric Corp.). U. S. Patent 3,079,319. Feb. 26, 1963. Filed Sept. 2, 1958.

An apparatus is designed for filling and draining a quasi-homogeneous slurry-type reactor. When the reactor is being started up, a dilute fuel solution is added to the reactor vessel until it is full, and then the fuel concentration is gradually increased to the operating concentration. (D.L.C.)

17524 ARRANGEMENT OF CONTROL BARS IN AN ATOMIC PILE. Jacky Weill (to Commissariat a l'Energie Atomique). U. S. Patent 3,079,320. Feb. 26, 1963. Priority date Jan. 29, 1958, France.

A novel arrangement of control bars in an atomic pile is described which involves only small displacement of the bars in their movement between operative and nonoperative positions. This movement is from an area shielded by fuel (nonoperative) to an unshielded area (operative). Several embodiments of the arrangement are described. (D.L.C.)

17525 FUEL ELEMENTS FOR NUCLEAR REACTORS. James Thomas Stockdale and Alan Frederick Taylor (to United Kingdom Atomic Energy Authority). U. S. Patent 3,079,322. Feb. 26, 1963. Priority date July 18, 1960, Great Britain.

A screwed end cap is designed for closing the ends of a sheathed fuel element. The end cap has an insert of fuel material in a circumferential groove in the skirt of the cap for giving early warning of faulty end seals, and longitudinal grooves are provided for venting the circumferential groove to the interior of the sheath. (D.L.C.)

17526 RADIOACTIVE FLUID HANDLING SYSTEM. Donald F. Rinald (to Westinghouse Electric Corp.). U. S. Patent 3,080,307. Mar. 5, 1963. Filed Oct. 21, 1957.

A gaseous fission product elimination system for homogeneous reactors is designed which permits adequate decay of the fission gases before venting and the reuse of the charcoal beds. The system includes a plurality of gaseous fission product adsorption tanks, means for separating the fission gases from the reactor system, means for coupling the separating means to the reactor system and to some of the adsorption tanks, and means for recirculating a carrier gas through the separating means and some of the tanks to give additional holding time for the fission gases. (D.L.C.)

17527 NUCLEAR REACTOR AND METHOD OF OPERATING SAME. Milton C. Edlund (to Babcock and Wilcox Co.). U. S. Patent 3,081,246. Mar. 12, 1963. Filed May 29, 1957.

A method is given for regulating a pressurized-water type reactor by varying its moderation. The moderation variation is obtained by using a H_2O-D_2O mixture which has initially a high D_2O concentration, and by varying the D_2O/H_2O ratio during operation to maintain a critical mass. (D.L.C.)

17528 NUCLEAR REACTORS. Peter John Grant (to General Electric Co. Ltd.). U. S. Patent 3,081,248. Mar. 12, 1963. Priority date Mar. 31, 1958, Great Britain.

A control system is designed for correcting neutron flux distortions in a reactor core. The system comprises a pair of neutron absorber members adapted to be inserted into different parts of the moderator and coupled so that movement of one member into the moderator is accompanied by movement of the other member out of the moderator. Thus, by the differential movement of the members, the fluxes in the two parts of the moderator can be adjusted without affecting the total flux. Two embodiments of the system are described. (D.L.C.)

Power Reactors

Refer also to abstracts 16188, 16315, 16573, 16575, and 16576.

17529 (ACNP-62034) PATHFINDER ATOMIC POWER PLANT TECHNICAL PROGRESS REPORT, JULY 1962–SEPTEMBER 1962. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Feb. 15, 1963. For Northern State Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 28p.

Progress on fuel element research and development and on reactor mechanical studies is reported. Thermal shocking of the superheater fuel element was begun and two cycles were completed. The apparatus and procedures are described. A two-dimensional transport theory analysis of the experimental low-enriched superheater (LESH) cells was performed. An H-900 F heat-treated and chrome-plated pinion shaft was tested during this period with a spare 304 stainless steel rack. The wear of the pinion teeth in the 13,000 full 72-in. cycles was negligible, proving that this type of pinion is satisfactory for the reference design in the Pathfinder control rod drive. (M.C.G.)

17530 (ACNP-62509) FUNCTIONAL TEST—BURST SLUG DETECTION SYSTEM. D. Luse (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Feb. 23, 1962. Contract [AT(10-1)-925]. 41p. (EGCR-STUDY-II-207)

Details of a functional check-out test are given for the EGCR burst slug detection system. A brief discussion of post operational testing is also given. (J.R.D.)

17531 (ACNP-63001) PATHFINDER ATOMIC POWER PLANT. BORON STAINLESS STEEL CONTROL RODS FOR

PATHFINDER REACTOR. Final Summary Report. D. A. Patterson, D. A. Nehrig, R. H. Klumb, and T. E. Peterson (Allis-Chalmers Mfg. Co. Atomic Energy Div., Milwaukee). Feb. 15, 1963. For Northern States Power Co., Minneapolis and Central Utilities Atomic Power Associates. Contract AT(11-1)-589. 54p.

An extensive development, fabrication, and design analysis program was completed on 2 wt % boron stainless steel for Pathfinder boiler and superheater control rods. Results indicated that the control rods will operate satisfactorily in the reactor under all foreseeable conditions. It was concluded that the maximum local burnup on the boiler rods is limited to 1.0 core at.% and the superheater rods to 0.5 core at.% to remain well below the onset of any deleterious effects. All stresses imposed on the material were found to be below yield strength. The deflections were calculated and were not sufficient to restrict any movement of the cruciform during reactor operations and scrams. A welding development program produced a sound fabrication method for producing the control rods. A prototype rod was extensively tested in the hot control rod drive test, including a large number of scrams. The rod showed no deleterious effects. The rods were designed to accommodate any helium release and swelling that may occur. (M.C.G.)

17532 (AMF-388-TR-2(Vol.I)) AMF ON-POWER REFUELING SYSTEM FOR THE DOUGLAS POINT PLANT. TASK 1 COMPLETION REPORT. VOLUME I. (AMF Atomics. Div. of American Machine and Foundry Co., Greenwich, Conn.). July 1962. Contract AT(38-1)-233. 172p.

Activities in a program to design, fabricate, and test a prototype on-power refueling machine suitable for operation with the CANDU-I reactor are reported. Work directed toward project advancement to the point at which the reference concept could be established, and component specifications completed is discussed. This five-chapter technical discussion is intended for use with Vol. II, a graphic supplement. (J.R.D.)

17533 (AMF-388-TR-2(Vol.II)) AMF ON-POWER REFUELING SYSTEM FOR THE DOUGLAS POINT PLANT. TASK 1 COMPLETION REPORT. VOLUME II. (AMF Atomics. Div. of American Machine and Foundry Co., Greenwich, Conn.). July 1962. Contract AT(38-1)-233. 53p.

Graphic coverage required to supplement Vol. I is presented. The arrangement is intended to complement the technical discussion in Vol. I by making available illustrations which are referenced in the text. (J.R.D.)

17534 (DLCS-5000163) MONTHLY OPERATING REPORT, JANUARY 1963. (Duquesne Light Co., Shippingport, Penna.). Contract AT(11-1)-292. 55p.

A summary is presented of significant operations, occurrences, and other station activities during this report period. Topics covered include: operations, station performance, incidents, chemistry, health physics, refueling, maintenance, test program, training program, and construction and major modifications. (M.C.G.)

17535 (GEAP-3967) HIGH POWER DENSITY DEVELOPMENT PROJECT, INTERIM REPORT, 300 MWe HPD CONCEPTUAL DESIGN STUDY. V. G. Grayhek and A. P. Bray (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). June 1962. Contract AT (04-3)-189. 21p.

As part of a 300 Mwe High Power Density Conceptual Design Study an analysis of reactor core power density and moderator void distribution was conducted. This analysis included development of a set of seven reactor core thermal hydraulic designs to prescribed power densities and moderator void fractions. The entire development will be employed in later phases of the overall Conceptual Design Study in which reactor design economics are to be considered. (auth)

17536 (GEAP-4057) DESIGN STUDY OF A 600 MWe BOILING WATER—SEPARATE SUPERHEAT REACTOR PLANT. R. A. Schmidt, S. F. Armour, and W. R. Clancey (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Sept. 1962. Contract AT(04-3)-189. 239p.

A cost estimate and design for a 607-Mw(e) boiling water-separate superheat reactor plant are presented. The superheat reactor is a pressure vessel, steam-cooled, water moderated reactor using UO_2 fuel. Saturated steam is supplied by a separate boiling water reactor. The work was undertaken to establish a reference separate-superheat design. (D.C.W.)

17537 (GEAP-4059) VIBRATION OF FUEL RODS IN PARALLEL FLOW. E. P. Quinn (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). July 1962. Contract AT(04-3)-361. 102p.

Measurements of parallel flow vibration in a prototype element of the first Consumers reactor core were obtained for reactor mass velocity and quality ranges at 1000 psia. Lateral fuel rod vibration between supports was determined to be a maximum of 0.0002 inches displacement near 50 cps. The vibration displacement for the case of one loose spacer would be about 0.001 inches at the spacer location. The vibration behavior was found to be nearly independent of mass velocity for low values and to rapidly increase in intensity with higher values of mass velocity. An independent analytical model for a single rod suspended in single phase flow was postulated on the basis that the mechanism was a self sustained oscillation. The solution of the model equations was compared to single rod observations and found to indicate the nature of vibration, the trends with parameters, and the magnitude and frequency of vibration for the region of strong dependence on mass velocity. The solution is also in agreement with the single rod data of Burgreen. The model may be used to estimate multi-rod vibration, but its use for two phase flow requires additional effort. (auth)

17538 (GEAP-4105) EVESR NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT. First Quarterly Report, May 4—August 31, 1962. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Contract AT(04-3)-189. 146p.

It is noted that the EVESR (ESADA Vallecitos Experimental Superheat Reactor) plant design and the design of the first core loading was in progress prior to the start of the reporting period. A description of the EVESR facility is included along with progress on the current (AEC sponsored) program. Significant progress reported includes preparation of task reference sheets for the entire program, virtual completion of Mark II EVESR core design, process development for Mark II fabrication, and completion of EVESR instrumentation and radiochemistry scoping. Work was initiated on a computer program for use with program data. (J.R.D.)

17539 (GEAP-4164) DEVELOPMENT PROGRAM FOR INCREASED OUTPUT IN THE GARIGLIANO REACTOR. Quarterly Progress Report No. 1, September—December 1962. E. P. Quinn (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 2, 1963. Work Performed under United States—Euratom Joint Research

and Development Program. Contract AT(04-3)-189. 18p. (EURAEC-528)

Activities in a program to obtain test data and operating experience necessary to effect a 50% increase in the output of the Garigliano Nuclear Power Station are reported. Specifications and drawings of test specimens of vessel materials, specimen capsules, and capsule hangers were issued. Fabrication of specimens of original vessel materials was initiated along with manufacture of standard heat material specimens and capsule hangers. Specifications describing computer input sensors, required additional instrumentation, and electrical cable were issued. Detailed cable routing and terminal designation diagrams were prepared, and purchase of instruments and equipment was initiated on the basis of funds made available by SENN. Final specifications for the Garigliano computer system were written. They are detailed specifications imposing exact requirements with respect to the features, components and performance of the total system. (J.R.D.)

17540 (HW-75731) TRANSIENTS FOLLOWING A HELIUM LINE FAILURE AT THE PRTR PRESSURIZER. R. W. Moulton and J. K. Anderson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 4, 1962. Contract AT(45-1)-1350. 8p.

A possible hazard in the operation of the PRTR that was not previously studied is the complete severing of one or more lines in the high pressure helium gas system feeding the pressurizer. The following questions were studied: what transient conditions would exist in the reactor core following the failure; what would be the D_2O level transient in the pressurizer following the failure; and would injection of light water be initiated automatically and in time to prevent fuel element melting? The basis for the calculations is the complete severing of a line supplying helium to the pressurizer at a point adjacent to the pressurizer. Under these conditions no make up helium would be available to the system and rather rapid depressurization would result. The primary coolant system pressure would decrease rapidly at first and then more slowly. As a consequence, vaporization would occur and there is some hazard with respect to the overheating of the fuel elements. During the first 20 seconds following a rupture, significant vaporization would occur around the fuel elements. This would then disappear. Additional vaporization would occur following loss of pump suction (between 2 and 5 minutes after rupture). This should not result in melting of the fuel elements. At the time of light water injection (about 5 minutes) the fuel elements could be overheated if the gate valve in the primary coolant outlet line were not manually opened to provide for circulation. Following the rupture described above, the D_2O level in the pressurizer would at first hold substantially constant, but after about 15 seconds it would start dropping rapidly until the pressurizer was emptied at about two minutes total time. Injection of light water would be initiated automatically and would only become effective when the system pressure had dropped to 100 psia (time about 5 minutes). However, inasmuch as the reactor and associated inlet and outlet piping would now be a closed system, the injection would soon be terminated due to pressure buildup unless the gate valve in the primary coolant outlet line were opened. These times assume that the present pressurizer vent valve opens when the pressurizer liquid level drops to the low-low level switch. (auth)

17541 (IDO-28602) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. Semiannual Progress Report, July 1 through December 31, 1962. (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AT(10-1)-880. 115p.

The ML-1 power plant produced electrical power for the first time on September 21, 1962. All objectives of the initial experiment were achieved. In general, plant performance was about as predicted with the exception that unanticipated high temperatures were observed in the upper tube sheet of the reactor calandria. This condition was subsequently attributed, in major part, to energy deposition in the tube sheet from hot gas flow which bypassed the fuel element insulation through imperfect fuel element seats. The shutdown period was devoted to installation of a dynamometer (for load absorption during future testing), installation of the Milletron Computer, installation of the deoxygenation system, and the completion of minor modifications to the plant. The IB-8T-2 (ML-1 first core prototype) in-pile experiment was concluded on October 7 after more than 10,000 hours of satisfactory operation. Investigations of the cause of embrittlement in the IB-8T-1 in-pile test specimen were continued without definite resolution of the phenomenon. Engineering work was completed, hardware procured, and disassembly and reassembly completed for the modification of the TCS-670 to improve performance and eliminate certain mechanical deficiencies. Engineering for the modification of the CSN-1 turbine compressor set to improve performance was completed. The assembly of the alternator and start motor was completed and preliminary performance tests of the alternator were initiated. The performance specification of the ML-1A power plant was completed and submitted to the USAEC. (auth)

17542 (NAA-SR-3740) TEN-YEAR SODIUM-REACTOR DEVELOPMENT PROGRAM. (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.) Apr. 11, 1959. Contract AT(11-1)-Gen-8. 28p.

A 10-year program of development and construction of large-scale, sodium-cooled reactors is summarized. The current state of development of the SGR and its associated components is sufficiently advanced to permit construction of economic plants within the 10-year period. Two advanced Sodium Reactor concepts are presented. A construction program involving two reactor experiments and two full-scale plants with a capacity of 550 Mwe, together with associated development, is estimated to cost $216 million. Of this amount approximately $106 million would be borne by the AEC and the remainder by power utility companies. Escalation and construction loan interest charges are included in these figures. The cost of power from the larger power plant would be approximately 6 mills/kw-hr, based on 1959 dollars. (auth)

17543 (NAA-SR-Memo-7521(Rev.)) STANDARDIZATION OF GAMMA PHA CALCULATIONS AT THE OMRE. L. D. Fielding (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 10, 1962. Contract [AT(11-1)-Gen-8]. 1p.

A compilation was made of the various correction factors and formulas required in the study of OMRE coolant by gamma pulse height analysis. The discussion and calculations are written as a reference and guide for laboratory technicians who perform the analysis. The use of standard techniques should both aid and improve the analyses. (auth)

17544 (NAA-SR-Memo-7952) PNPF TWO-ZONE CORE TEMPERATURE DISTRIBUTION. K. L. Adler (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 13, 1962. Contract [AT(11-1)-Gen-8]. 11p.

A two-zone orificing arrangement is proposed for the

Piqua Nuclear Power Facility (PNPF) core, with 43 unorificed elements and 42 orificed ones. An initial core configuration of 61 elements is derived by omitting the outer row of 24 elements from the full 85-element core. In order to attain the same hot-spot temperatures in the hottest orificed and the hottest unorificed elements, the flow in the orificed elements is restricted to 78% of the flow in the unorificed elements. (auth)

17545 (NAA-SR-Memo-8053) FUEL-HANDLING HEAT TRANSFER ANALYSIS. J. J. Hammer (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Dec. 26, 1962. Contract [AT(11-1)-Gen-8]. 24p.

Results of an analysis of the fuel handling gas-to-gas heat exchanger system for ASCR fuel element decay heat removal are presented. The use of Ar and He were considered in cases where decay heat rates were 25 and 40 kw. (J.R.D.)

17546 (SRO-80) HEAVY WATER POWER REACTOR PROGRAM MONTHLY PROGRESS REPORT, FEBRUARY 1963. (Savannah River Operations Office, AEC). 11p.

Progress is reported on the AEC/AECL cooperative program, development of sintered aluminum products, non-destructive tests, fluid dynamics in header and feeder piping, zirconium technology, heavy water plants, Euratom cooperative program, reactor materials and equipment development, Heavy Water Components Test Reactor, and Carolinas-Virginia Tube Reactor. (M.C.G.)

17547 (TID-18095) GAMMA HEATING CORE STRUCTURE METALLIC COMPONENTS. EXPERIMENTAL GAS COOLED REACTOR. M. J. Barrett (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Apr. 21, 1960. Contract AT(10-1)-925. 49p. (EGCR-STUDY-II-100)

Conclusions concerning the heat production in the steel structures used to support and position the EGCR Core are presented. Heating rates owing to core gamma radiation and to the absorption of thermal neutrons in the structures are considered. (J.R.D.)

17548 (TID-18096) NEUTRON STREAMING FROM THE EGCR CORE. EXPERIMENTAL GAS COOLED REACTOR. M. J. Barrett (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). May 11, 1960. Contract AT(10-1)-925. 37p. (EGCR-STUDY-II-105-4)

Estimates of neutron currents resulting from streaming from fuel channels in the EGCR graphite core are given. These data are required to evaluate the radiation damage to top and bottom hemispheres of the reactor pressure vessel, for use in shielding calculations, and to evaluate leakage probability in criticality calculations. (J.R.D.)

17549 (TID-18097) SHIELDING ANALYSIS OF THE SERVICE MACHINE. EXPERIMENTAL GAS COOLED REACTOR. M. J. Barrett (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). June 1, 1960. Contract AT(10-1)-925. 71p. (EGCR-STUDY-II-104-1)

An analysis of the normal operating schedules of the EGCR service machine is presented along with data on induced radiation in the machine, and design of a service machine shielding system which meets EGCR specifications. (J.R.D.)

17550 (TID-18098) TEMPERATURE DISTRIBUTION MODERATOR AND REFLECTOR REACTOR CORE. EXPERIMENTAL GAS COOLED REACTOR. F. Cheng (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Apr. 25, 1960. 85p. (EGCR-STUDY-II-226)

A study was made to determine the coolant flow required to prevent the temperature of the graphite moderator and reflector blocks from exceeding 1100°F at full-power operating conditions. The temperature distribution in the graphite blocks was also determined. The moderator was primarily cooled by coolant flowing in the $\frac{1}{8}$-inch annulus formed by the fuel-assembly sleeves and the fuel-channel holes in the moderator blocks. Coolant flow in the control-rod channels and in the experimental-tube coolant annuli also cooled the moderator, and this effect was considered in setting moderator-annulus coolant flow. The coolant flows required for each of four zones in the reactor core were determined. The total moderator-annulus coolant flow (excluding 16 unfueled channels) was 15,200 lb/hr. The moderator-block temperature distributions for full-power reactor operation after 20 years of operation are given. The maximum temperature (1100°F average over the cross section) occurred near the top of the graphite block. The temperature in the majority of the graphite columns varied from 600 to 1000°F over the lower half of the column and from 1000 to 1100°F over the top half of the column. The maximum graphite surface temperature was less than 1100°F. Reflector-block temperatures (average over the cross section) did not exceed 1050°F. The axial temperature distribution was approximately linear over the length of the column and varied from 550°F at the bottom to 1050°F at the top. Axial temperature distribution for each reflector column is also shown. The maximum temperature difference over a column cross section was less than 150°F for normal full-power operation. A maximum temperature difference of 450°F over a column cross section was calculated for the condition in which one of the fuel channels has 3500 lb/hr of coolant with no fuel assemblies. The time required for this temperature difference to develop in the column is about 10 minutes after start of unloading. (auth)

17551 (TID-18099) DESIGN AND ANALYSIS—CORE GAS SEALS. J. P. Ferratt, Jr. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Mar. 6, 1960. Contract AT(10-1)-925. 70p. (EGCR Study No. II-233)

A study was conducted to evaluate various types of sealing devices to determine their suitability for use as the gas seal between the graphite column and bottom support plate for the EGCR core. The optimum seal configuration with respect to performance, erection, economics, and relations with other components was also studied. It was concluded that the bellows-type face seal is the best design available. Other conclusions are also included. (J.R.D.)

17552 (TID-18101) COOLING REQUIREMENTS FOR FUEL ASSEMBLIES DURING HANDLING WITHIN REACTOR. L. L. Kintner (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). May 16, 1960. Contract [AT(10-1)-925]. 35p. (EGCR-STUDY-II-129)

Experimental Gas Cooled Reactor fuel assembly cooling requirements were studied for charge-machine loading and unloading of individual fuel columns, loading and unloading fuel assemblies singly, and unloading instrumented fuel columns. Conclusions concerning cooling specifications are included. (J.R.D.)

17553 (TID-18102) INSTRUMENTATION FOR THE INSTRUMENTED FUEL COLUMN. D. A. Lampe (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Mar. 3, 1960. Contract [AT(10-1)-925]. 21p. (EGCR-STUDY-II-151)

Information concerning preparation of design drawings of the instrumented fuel column for the EGCR is presented. Details concerning routing of thermocouple leads, flow sensor leads, and attachment of top dummy assembly to shield plug are given. (J.R.D.)

17554 (TID-18106) FAST NEUTRON LEAKAGE. E. Wagner (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Feb. 22, 1960. Contract [AT(10-1)-925]. 22p. (EGCR-STUDY-II-105-2)

Studies were made to determine the fast-neutron leakage out of the top and bottom of the pressure vessel of the Experimental Gas Cooled Reactor. The maximum value of the neutron flux at the outside surface of the reflector at the ends of the core is approximately 0.6 of the same quantity in the radial direction. The maximum flux, above 1 Mev in energy, at the radial and axial outside surfaces of the reflector are, respectively: 2.0×10^9 n/cm^2 sec and 1.25×10^9 n/cm^2 sec. The maximum axial flux, above 1 Mev in energy, at the inside surface of the pressure vessel on the vertical axis of the core is approximately 1.0×10^8 neutron per cm^2 sec. This is much less than the maximum in the radial direction, which is approximately 1.5×10^9 neutrons per cm^2 sec, so that fast-neutron radiation damage due to diffusion of neutrons out of the reactor will accumulate much faster on the radial portion than on the hemispherical top and bottom heads of the pressure vessel. The results calculated for the maximum radial flux are compared with results from a moments-method calculation. The moments method gives a higher flux value by a factor of 1.4. (auth)

17555 (TID-18108) STATUS REPORT OF NORA PROJECT. [Period Covered] June 1 to November 1, 1962. (Norway. Institutt for Atomenergi, Kjeller). November 1, 1962. Contract [AT(30-1)-2623]. 6p. (NC-38)

A summary of work on the NORA project during the period June to Nov. 1962 is presented. Data and information are included on NORA operation, use of JEEPNIK, and program publications. (J.R.D.)

17556 (TID-18229) MODEL STUDIES OF REACTOR COOLANT AND FUEL PIN BEHAVIOR UNDER CONDITIONS OF COOLANT BOILING AND OVERHEATING OF THE FUEL ELEMENTS. Engineering Research Department Report 59D65. J. O. Smith, C. J. Shuttleworth, and G. C. Kaercher (Detroit Edison Co., Detroit). Nov. 20, 1961. Contract [AT(11-1)-865]. 41p.

Studies were made to obtain experimental data by which the behavior of the coolant and fuel elements of the Enrico Fermi Reactor can be predicted under conditions beyond those of normal operation. A model test section was constructed that simulated the passages for coolant flow through partial cross sections of a reactor core subassembly, upper blanket subassembly, and lower blanket subassembly with inlet nozzle. The model core section was 1 cm square in cross section and contained 4 dummy fuel pins, which were electrically heated. The blanket models were round tubes of such proportions that the percentage of the total pressure drop through each of the sections was approximately equal to the pressure drop percentage in the corresponding reactor component. The test section was incorporated in a vertically oriented test loop in which water at reduced pressure was circulated as coolant. Results of tests on two-phase flow, liquid expulsion, natural circulation, and meltdown are presented. (M.C.G.)

17557 (TID-18235) DESIGN AND ANALYSIS OF CORE PERIPHERAL RESTRAINTS. Paul V. Goulden (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). July 8, 1960. Contract [AT(10-1)-925]. 23p. (EGCR-STUDY-II-240)

Peripheral restraints for the graphite core of the EGCR were designed and analyzed. The restraints serve to prevent excess bowing of the core columns and therefore must be capable of withstanding the forces exerted by the columns as they tend to bow. There are 3 restraints, each consisting of one band surrounding the core and each with one bearing plate for each outer graphite column. They are supported by 8 vertical stanchions spaced around the core. Leaf springs are used to accommodate the axial differential expansion between the stanchions and the graphite. Materials for the bands were selected so that radial thermal expansion of the core structure is also accommodated. (M.C.G.)

17558 (TID-18237) DESIGN AND ANALYSIS OF TOP GRID STRUCTURE AND ASSOCIATED COMPONENTS. A. Meyerhoff (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). May 25, 1960. Contract [AT(10-1)-925]. 146p. (EGCR-STUDY-II-229)

The designs of the top grid structure, the restraint lattice, and associated components for the Experimental Gas Cooled Reactor are described. The material used for all parts is Type 502 corrosion-resistant steel. The grid structure members are 12-in. deep by $\frac{3}{4}$-in. thick. The maximum stress is a bending stress of 1253 psi, which is within the allowable stress of 1500 psi at 1200°F. The maximum deflection due to creep sag is approximately 0.25 in. Lattice beams are $\frac{7}{8}$-in. thick and 7-in. long. The lattice is doweled to the grid ring girder on erection to facilitate positioning and for transmission of seismic loads. The design of core fuel-channel extensions, plates, ring girder, and top keys is also discussed. (M.C.G.)

17559 (TID-18238) TEMPERATURE DISTRIBUTION, MODERATOR AND REFLECTOR REACTOR CORE. F. Cheng (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Dec. 21, 1960. Contract [AT(10-1)-925]. 51p. (EGCR-STUDY-II-226, Suppl.1)

Studies were made to determine revised moderator coolant flow requirements in the EGCR core for the latest design. The temperature distribution in the graphite columns was also determined. The total moderator coolant flow was calculated to be 24,024 lb/hr and 31,020 lb/hr for full power and maximum anticipated power, respectively. It was concluded that the maximum moderator temperature (1220°F average over the cross section), at full power operation, occurs near the peak heat flux at a location 6.25 to 7.25 ft from the bottom of the active core. The temperature in most of the graphite columns varies from 555 to 1150°F over the lower half of the column and 1150 to 990°F over the top half of the column. The maximum surface temperature is less than 1110°F. Temperature distributions are shown on graphs. (M.C.G.)

17560 (TID-18239) DESIGN REQUIREMENTS—CORE STRUCTURE. James V. Neely (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Dec. 11, 1959. Contract [AT(10-1)-925]. 22p. (EGCR-STUDY-II-225)

Design requirements for the EGCR core structure are stated. Studies were made of functions, relationship to other parts, materials, general dimensions, and operating conditions for the EGCR core structure. Requirements are discussed for bottom support plates, graphite core structure, top restraint lattice, top grid structure, core channel extensions, core cover plates, core gas seals, and peripheral restraints. (M.C.G.)

17561 (TID-18240) DESIGN OF THE PNEUMATIC TEMPERATURE MONITORING SYSTEM. D. A. Lampe (Allis-Chalmbers Mfg. Co. Atomic Energy Div., Washington, D. C.). Sept. 1, 1960. Contract [AT(10-1)-925]. 38p. (EGCR-STUDY-II-180)

The design of the pneumatic temperature monitoring (PTM) system and its effects on the performance of the

burst slug detection system are described. The temperature monitoring system is designed for scanning outlet gas temperature of individual fuel channels during steady-state reactor operation, throughout the lifetime of the reactor. The system is a backup for the reference design thermocouple system for measuring outlet gas temperature. The PTM system utilizes the available burst slug detection system sampling tubes from the reactor core fuel channel extensions through the manifolds. (M.C.G.)

17562 (TID-18241) BURST SLUG DETECTION EQUIPMENT SHIELDING—ANALYSIS. D. Luse (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Nov. 16, 1960. Contract [AT(10-1)-925]. 31p. (EGCR-STUDY-II-204)

Studies were made to determine the dose rates internal and external to the BSD (burst slug detection) equipment and compressor rooms for the EGCR. Six cases based on 1000°C in the reactor coolant were examined. The maximum dose rate expected in the equipment room is 68 mr/hr. It was concluded that a 2-in steel slab should be incorporated in the floor design above the BSD suction vessel. The north wall should provide equivalent gamma shielding of an 8-in. solid concrete wall. The equipment rooms should consist of 12-in. thick ordinary concrete. (M.C.G.)

17563 (TID-18242) DESIGN REQUIREMENT—BURST SLUG DETECTION SYSTEM. D. Luse (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Nov. 6, 1959. Contract AT(10-1)-925. 19p. (EGCR-STUDY-II-200)

The design conditions and functional requirements of the burst slug detection system for the Experimental Gas Cooled Reactor are defined. The system consists of two sub-systems, the sample gas handling system and the instrumentation and readout system, which are interconnected by wire-precipitator monitors. Where applicable, portions of the Pneumatic Temperature Measuring (PTM) system were incorporated to determine requirements and design conditions. The system is designed to detect failed fuel elements only when the reactor percent power to percent flow ratio is one or nearly one. Location of the defective element is by fuel channel. (M.C.G.)

17564 (TID-18243) RADIAL FAST NEUTRON LEAKAGE FROM EXPERIMENTAL GAS COOLED REACTOR. P. M. Wood (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Mar. 7, 1960. Contract AT (10-1)-925. 18p. (EGCR-STUDY-II-105-3)

Results of investigations concerning the radial leakage flux of neutrons greater than 1 Mev at the EGCR core reflector outer edge are presented. A comparison of results obtained by use of the moments method and a multi-group diffusion theory is also presented. (J.R.D.)

17565 (TID-18244) DESIGN AND ANALYSIS: CORE STRUCTURE [AND] BOTTOM PLATE. Paul V. Goulden (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Apr. 21, 1960. Contract [AT(10-1)-925]. 18p. (EGCR-STUDY-II-231)

A study was conducted to design the EGCR bottom support plate and to calculate its critical dimensions. Calculations were made which show that the plate and positioning keys meet the design requirements. Work sheets pertaining to the evaluation are included along with references to drawings. (J.R.D.)

17566 (TID-18245) THERMAL AND TOTAL EPITHERMAL NEUTRON FLUX DISTRIBUTIONS IN THE EXPERIMENTAL GAS COOLED REACTOR. E. Wagner (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Feb. 23, 1960. Contract AT(10-1)-925. 31p. (EGCR-STUDY-II-105-1)

The thermal and total epithermal neutron flux distributions in the EGCR from the center of the core through the biological shield were calculated. The maximum values of the flux distribution are presented in graph form. Ordinary concrete was found to permit a thermal flux buildup, similar to that found in the graphite reflector. In heavy concrete there was no such buildup seen, since the thermal flux is attenuated through the complete shield. A Val Prod code using multigroup diffusion theory was used to calculate the neutron flux distributions. Calculations are shown. (M.C.G.)

17567 (TID-18247) DESIGN REQUIREMENT—DUMMY FUEL ASSEMBLIES. (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Jan. 11, 1960. Contract AT(10-1)-925. 19p. (EGCR-STUDY-II-175)

The functional requirements of the dummy fuel assemblies and the specific conditions for which they are designed are defined. Requirements discussed include: pressure drop conditions, design lifetime, handling, interchangeability, compatibility with related equipment, allowable unit stress, performance, and environmental conditions. (M.C.G.)

17568 (TID-18248) REACTOR CORE COOLANT FLOW DISTRIBUTION. L. H. Devlin (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Dec. 9, 1960. Contract [AT(10-1)-925]. 29p. (EGCR-STUDY-II-179-1).

Studies were made to determine coolant flow distribution to the core components, excluding fuel assemblies. The calculated coolant flow that by-passes the fuel elements is 39,275 lb/hr. The sources are: moderator coolant annuli, control rods, small experimental tubes, fuel-channel gas seal leakage, excess flow for fuel unloading, and excess flow for servicing operations. It was concluded that no coolant flow is required for flux scanner tubes or graphite plugs in large experimental loop channels. It was calculated that coolant leakage is negligible past ring seals in large experimental loop channels and gaps between graphite column and support plate at small experimental loop locations. (M.C.G.)

17569 (TID-18249) DESIGN AND ANALYSIS: THERMAL COLUMNS AND ACCESS TUBES. R. Moreno-Castro (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). June 7, 1961. Contract [AT(10-1)-925]. 31p. (EGCR-STUDY-II-242)

Design basis for the nuclear instrumentation access tubes and thermal columns for the Experimental Gas Cooled Reactor system is presented. The entrance to the access tubes is at the level of the service machine room in the reactor building. The access tubes penetrate the biological shield so that their lower end emerges in the reactor vault at or near the reactor horizontal center line. Normally the neutron detectors are located at the lower end of the access tubes and remain there during reactor operation unless removal for repair or replacement is necessary. Startup range detectors are withdrawn up and into the access tubes as the reactor power level increases. Thermal columns are required in the start-up access tubes at the lower end on the reactor side of the biological shield in order that enough neutrons are thermalized so that a count is recorded by the startup detectors at startup before rods are pulled to start the reactor. (M.C.G.)

17570 (TID-18250) REACTOR VESSEL AND CORE ALIGNMENT OF CONTROL RODS AND CONTROL ROD CHANNELS. S. Matovich (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). June 21, 1962. Contract [AT(10-1)-925]. 33p. (EGCR-STUDY-II-249)

The dimensional requirements to assure control rod freedom in the reactor core control rod channels at ambient, isothermal, and operating temperature levels were determined. The requirements for additional evaluations to assure that fabricated or "as-built" dimensions do not impair the ability to insert control rods into the reactor core control rod channels or the ability to insert service machine tools into the reactor vessel as required for reactor service operations are specified. (M.C.G.)

17571 (TID-18251) ANALYSIS—GRAPHITE CORE STRUCTURE. R. R. Newton (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Dec. 14, 1960. Contract [AT(10-1)-925]. 276p. (EGCR-STUDY-II-227)

A study was made to determine the structural and functional adequacy of the EGCR graphite core design. Maximum stress and distortion of the core and the probable operating time before graphite cracking were determined. The major cause of stress is non-uniform fast-neutron flux, which causes non-uniform shrinkage of graphite components. The critical stress was found to be tensile. The criterion for determining the time of cracking of graphite columns appears to be the point at which the creep strain results in rupture. Column life before cracking may also be related to the maximum allowable stress at rupture. It was concluded that non-uniform shrinkage is the major cause of distortion of graphite components of the core. In general the amount by which a column tends to bow during 20-year core life exceeds the available free space. The combined internally generated and bowing stresses result in an average period before cracking of all core columns of 14 years, with a minimum period of 6 years. (M.C.G.)

17572 (WAPD-PWR-TE-103) TRITIUM CONCENTRATION IN PWR USING LITHIUM^{7} RESIN. DLCS-3760101. W. Lechnick (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1962. Contract AT(11-1)-Gen-14. 5p.

A changeover from Li^{nat} OH resin to Li^{7}OH resin at PWR reduced tritium concentration in the primary coolant by approximately a factor of 100. This decrease was reflected in the monthly waste disposal discharge thus reducing the amount of activity which is discharged to the effluent channel. (auth)

17573 (WAPD-PWR-TE-128(Rev.)) REACTOR COOLANT RADIONUCLIDE BASE LEVELS. PWR Core 1, Seed 3. W. Lechnick and P. E. Brown (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Mar. 1963. Contract [AT(11-1)-Gen-14]. 9p.

Base level fission product activity levels for PWR Core 1 Seed 3 operations were slightly below base levels observed for Core 1 Seed 2 operations, indicating that the replacement seed had a relatively low U contamination level. Absolute contamination levels of the replacement seed could not be determined because of background activity from the blanket fuel. Mg^{56} activity (Mn^{56} and Mn^{54} were the only corrosion product activities determined) was up from Core 1 Seed 2 base level values. While the reason for the increase was not established it is concluded that the phenomenon is of little significance since even at the Seed 3 levels, Mn^{56} constitutes less than 4% of the gross gamma activity one hour after sampling. (auth)

17574 (WAPD-T-1461) EVALUATION OF ISOTOPIC CONTENT OF IRRADIATED NATURAL URANIUM DIOXIDE FUEL RODS FROM PWR CORE 1. C. D. Sphar (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). [May 1962]. Contract AT(11-1)-Gen-14. 23p.

Results of an investigation of PWR natural-UO_2 fuel elements after 5806 equivalent full power hr of operation are presented. A description of analytical techniques used is included along with data on fuel rod compositions and comparison of calculated and theoretical results. (J.R.D.)

17575 OPERATIONAL EXPERIENCES WITH THE "DRESDEN" REACTOR. Ferruccio Ferroni. Atom u Strom, 8: 85-6(Dec. 1962). (In German)

In the determination of atomic energy costs there are many unknown factors which must be estimated because of lack of experience, as, for example, utilization factor, burn-up, safety, and controllability. In the operation of the Dresden Reactor, a boiling water reactor with a two-circuit system, some of these factors were investigated on the basis of experiences up to the present. Some of these factors, as established by Dresden operations, are discussed. (J.S.R.)

17576 CHARACTERISTIC QUALITIES OF SOME ATOMIC POWER STATIONS. Gyoergy Ligeti. Energia Atomtech., 15: 178-89(Apr. 1962). (In Hungarian)

Mostly as the result of economic factors, the current rate of construction of public atomic power stations has slowed down. The use of atomic energy is considered economical only in a few special cases, such as ship propulsion or supplying power to remote regions. For this reason, many reactors were designed especially for the construction of such "midget" power stations, operating at power levels ranging from 10 to 70 Mw. Technical details are given of such already-built or proposed systems, including the following: pressurized-water reactors such as the Babcock and Wilcox 60-Mw reactor, using 2.4% U^{235} fuel; the Humphrey-Glasow Company's 20 Mw reactor; the gas-cooled system of the de Havilland Company; the organic-moderated reactor of the English Electric Company; the organic-moderated system of the Hawker-Siddeley Nuclear Power Company; the boiling-water reactor of the Mitchell Engineering Company and the steam-cooled, heavy-water reactor of the Rolls-Royce & Vickers Company. (TTT)

17577 PROSPECTS FOR HEAVY-WATER REACTORS. SECOND PART. J. S. Foster. Europa Nucl., 6: 33-9 (Jan.-Feb. 1963). (In English) (Also in Italian; German; and French)

Cost estimates and unit-energy costs are given for a two-unit installation at Douglas Point Station in Britain. Capital-cost and unit-energy cost comparisons are given between the Bodega Bay Plant (USA, 313 Mw(e) net) and a 300-Mw(e) version of the Douglas Point unit. The present situation of nuclear fuel costs in USA is discussed briefly. The economy of heavy-water reactors as compared with gas-cooled graphite and enriched light-water reactors is discussed, and the probable future of heavy-water reactors in the nuclear power programs of the world is considered. (D.L.C.)

17578 A PRELIMINARY REPORT OF AN INVESTIGATION OF THE EFFECTS OF SHIP MOTION ON BOILING WATER REACTORS. G. L. West, Jr. and Hideaki Nishihara (Univ. of Michigan, Ann Arbor). J. Joint Panel Nucl. Marine Propulsion, 6: 43-55(Oct. 1962).

The present study shows that ship motion can have an important effect on the dynamics of boiling water reactors. Previous work has, in general, confirmed this result. No attempt was made to find the extremes of this effect since the work up to the present has aimed at developing a be-

lievable method of analysis. The study was not carried further because it was realized that further refinement was necessary. A discussion is given on the modification of the reactor equations used to obtain the results. Essentially, these modifications include the effects of core-pressure variation and the effects of a riser or chimney above the core. It was assumed that there was no direct coupling between the motion and reactivity. All the coupling was introduced by considering only changes in g, or gravitational effects. These, in turn, directly affect the water circulation in the core, which is caused by the effective density difference between the core and downcomer regions. Since the acceleration affects the core pressure, which in turn influences f, the steam-void fraction, the results omit an important motion-reactivity coupling effect. Equations were developed which take account of this coupling, but they have not yet been programmed for the computer. (auth)

17579 FIRST GERMAN SHIP WITH NUCLEAR PROPULSION. E. Bagge and K. Diebner. Kerntechnik, 5: 28-30(Jan. 1963). (In German)

The development of the ship is described briefly. After the completion of preliminary sketches, a contract was signed on Nov. 28, 1962, for the construction of the ship. The original plan was for the reactor to be organic-moderated and gas-cooled, but it can be changed, as the ship is designed to be independent of the reactor type. The three reactor types and their state of art are outlined: organic-moderated, pressurized-water, and combined reactor-boiler. The proposed future development program for the ship is outlined briefly. (D.L.C.)

17580 BRITISH PLANS FOR NUCLEAR SHIPS. R. P. Kinsey (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). New Scientist, 17: 393-5(Feb. 21, 1963).

The expected schedule of work for the development and construction of a British nuclear-powered merchant vessel is described briefly. Two reactor systems were selected for development: the Vulcain advanced pressurized-water reactor and the Integral Boiling Reactor. The history of nuclear power for merchant ships in Britain and other countries is reviewed. Two advances in reactor design which enhance the economic position of nuclear power are discussed: spectral shift or variable moderator control and packaged reactors. (D.L.C.)

17581 THE U.K. ATOMIC ENERGY AUTHORITY'S NUCLEAR SHIP CONCEPTS. Nucl. Energy, 88-9(Mar. 1963).

UKAEA expects in the fall of 1963 to be able to select between their two concepts, the IBR (direct-cycle and indirect-cycle versions) and the Vulcain (spectral shift) reactor. Both concepts are integral and can be removed entirely from the ship for replacement. The ship size, capital costs, and fuel burnups are considered briefly. (D.L.C.)

17582 INDIAN POINT ON THE LINE. Nucleonics, 21: No. 4, 47-52(Apr. 1963).

A complete description is given of Indian Point, a pressurized-water reactor fueled by a combination of uranium and fertile thorium. Its characteristics are tabulated. The reactor vessel, shielding, control rods, and heat transfer equipment are discussed. The startup and early operating experience (first criticality attained on August 2, 1962) are discussed. (D.L.C.)

17583 WELDED STRUCTURAL ELEMENTS OF A NUCLEAR POWER PLANT. Eberhard Leinhos and Johannes Krebs. Schweisstechnik (Berlin), No. 3, 103-6; 130(1962).

A general review of structural elements based on observations on the West German 15-Mw boiling-water nuclear test power plant, Kahl, is presented. The application of welding techniques is mentioned as an important feature for the construction of structural elements for nuclear power plants. Austenitic steel of Soviet origin is used for nuclear power plant elements, although there is a danger of the formation of heat cracks. (P.C.H.)

17584 OPERATION OF NUCLEAR REACTOR PLANTS. (to Shell Internationale Research Maatschappij N.V.). British Patent 918,839. Feb. 20, 1963. Priority date Dec. 8, 1960, Netherlands.

A combustible organic liquid material is employed as a reactor coolant. The liquid absorbs and removes heat liberated by the nuclear fuel, produces steam from the heat contained, and then is burned wholly or in part to raise the temperature of at least part of the steam produced. The portion burned is replaced by fresh organic material. It is thus possible to employ heat-exchange fluids that are too unstable to be considered unsuitable for use in reactors. Such fluids are much cheaper than the very stable chemicals. (C.E.S.)

17585 NUCLEAR POWER REACTOR. (to Dow Chemical Co.). British Patent 919,637. Feb. 27, 1963. Priority date Oct. 28, 1958, United States.

The reactor comprises a reactor core constructed of a fissile material and a neutron injecting device, both being subcritical. The neutron injecting device is capable of injecting neutrons into the reactor core in such proportions that the reactor becomes and remains critical. (C.E.S.)

17586 METHOD OF AND APPARATUS FOR PRODUCING ELECTRICAL ENERGY FROM NUCLEAR FUEL. Joseph Anthony McWilliams (to Boucher and Co. Ltd.). British Patent 920,198. Mar. 6, 1963. Filed July 5, 1958.

A method and apparatus are described for producing electrical energy from nuclear fuel. The heat energy generated in a moderated or unmoderated nuclear fuel element produces electron emission from a surface in thermal communication with the fuel element. The collector electrode is surrounded by a gas, which undergoes ionization to facilitate electron transit. (C.E.S.)

17587 GAS COOLED NUCLEAR REACTORS PROVIDED WITH A HEAT EXCHANGER FOR THE GENERATION OF STEAM. (to Brown, Boveri & Cie., A. G. and Beteiligungs-und Patentverwaltungs-Gesellschaft mit Beschrankter Haftung). British Patent 921,448. Mar. 20, 1963. Priority date, Jan. 27, 1959, Germany.

A reactor cooled by rare gas and having a heat exchanger is designed with the space containing the heat exchanger separated from that containing the core by a permeable partition. A safety device is provided which comprises a cooler and a containment vessel connected by a membrane to the space containing the core. Some of the advantages of the reactor are that the heat exchanger is protected against overheating by the partition and that the cooler reduces the volume of the gas by removing the steam. (D.L.C.)

17588 FUEL ASSEMBLY ARRANGEMENT IN THE FUEL CORE (ACTIVE ZONE) OF A HETEROGENEOUS POWER NUCLEAR REACTOR. Hans-Heinrich Spillmann. German Patent 21374. June 21, 1961.

A fuel assembly of rectangular or trapezoidal cross section is proposed in which the location of the fuel element in the cross section of the fuel core changes from periphery toward center thus eliminating nonuniform burning of the fuel elements in various assemblies throughout the operation of the nuclear reactor. The peripheral fuel-assembly layers are located tangentially, gradually approaching a

radial type of location in layers closer to the core center. Central fuel assemblies are located exactly in a radial direction. Location of fuel assemblies in the core may be varied during reactor operation. Though cross section and location of fuel assemblies may differ from the type described, they must be in strict accordance with the hydrodynamic flow conditions for the reactor coolant. (Referativnyy Zhurnal, Otdel'nyy vypush, 42, 1962)

17589 NUCLEAR REACTOR CONTROL. Pierre Marie Le Baud, Petit Clamart, Jean Lacour, Deuil la Barre, and Victor Raievski (To Commissariat a l'Energie Atomique). U. S. Patent 3,079,315. Feb. 26, 1963. Priority date May 16, 1957, France.

A system is designed for controlling the operation of power reactors whose load is variable, e.g., propulsion reactors on ships. In this system, the reactivity is measured continuously by cyclically varying the multiplication factor and monitoring the variations in the reactor neutron flux, and the reactor is operated in response to the variations. (D.L.C.)

17590 STABILIZING SYSTEM FOR NUCLEAR REACTORS, PARTICULARLY THOSE OPERATING WITH BOILING WATER. Claude Samuel (to Societe Indatom). U. S. Patent 3,080,309. Mar. 5, 1963. Priority date Dec. 3, 1958, France.

A system is designed for stabilizing the operation of boiling reactors at high power levels. The system comprises a neutron flux detector, a correcting circuit adapted to produce a lead in phase, a neutron-absorbing member of variable area, and an auxiliary control mechanism for moving the member in response to the output of the correcting circuit. The correcting circuit has an increasing gain vs frequency characteristic, which may be considered to cancel out the counter-reactivity of the bubbles. (D.L.C.)

Research Reactors

17591 (ANL-6107) FABRICATION OF THE FUEL AND BLANKET FOR THE ARGONNE FAST SOURCE REACTOR (AFSR). W. R. Burt, Jr. (Argonne National Lab., Ill.). Jan. 1963. Contract W-31-109-eng-38. 45p.

The development and the manufacture of the core and the manufacture of the blanket for the Argonne Fast Source Reactor (AFSR) are described. A detailed account of the operations of casting, rolling, machining, and jacketing is included. The core consists of 4.5-in.-diameter uranium discs enriched to 93 wt % U^{235}. These discs were vacuum sealed in 0.005-in.-thick nickel cans. Two cans contained a 1.302-in.-thick disc in each and the remaining can contained a series of 0.050- to 0.565-in.-thick discs. The blanket is a thick-walled, right circular cylinder of bare, depleted uranium. This cylinder is $20^{5}/_{8}$ in. in O.D. × $20^{5}/_{8}$ in. high with an 8-in. wall thickness. It was made up of five individual rings stacked upon each other. Top and bottom plugs of depleted uranium completed the blanket after positioning of the core in the reactor. (auth)

17592 (DP-600) FINAL HAZARDS EVALUATION OF THE HEAVY WATER COMPONENTS TEST REACTOR (HWCTR). L. M. Arnett, Duncan Randall, Charles P. Ross, Ben C. Rusche, and Charles D. Taylor (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Dec. 1962. Contract AT(07-2)-1. 294p.

The Heavy Water Components Test Reactor (HWCTR) is designed to test as many as 12 U fuel assemblies, up to 10 ft long, at power ratings and exposures expected in full-scale power reactors. The HWCTR is a pressurized reactor that is moderated and cooled with D_2O. The maximum power is about 70 Mw and the design pressure is 1500 psi at 315°C. Features of the reactor design that affect reactor safety are described and representative accidents are followed through conditions in the reactor, action of the safety systems, and subsequent action of the emergency backup facilities. In the majority of accidents considered, the negative temperature coefficient of the moderator prevents serious consequences. In the case of a major break in the pressure system, the spread of radioactivity is limited by the containment building in which the reactor is housed. (auth)

17593 (HW-SA-2945) INSTRUMENTATION AND CONTROL OF AN IN-REACTOR TEST FACILITY. J. R. Bolliger (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). [Mar. 8, 1963]. Contract AT(45-1)-1350. 23p.

The control and instrumentation systems associated with a pressurized water cooled nuclear fuel test facility are described. The facility consists of four in-reactor recirculating water cooled loops, each having four automatic control systems and one safety system. A detailed description of the four prime automatic control systems as well as the safety circuit is given. In addition, since this facility is operated in conjunction with a plutonium production reactor, it has very stringent restrictions placed on it. Some revisions, necessary because of this association, were required and are related. Diagrams of the control systems, loops, and safety systems are included. (auth)

17594 (IOI-158) THE COBALT SPILL AT NRX, JULY 1958. K. W. Reid (Atomic Energy of Canada Ltd. Chalk River Project, Chalk River, Ont.). Sept. 19, 1958. Reprinted Jan. 1963. 47p. (AECL-1665)

On July 17, 1958 at 1504 hours the NRX reactor at the AECL, Chalk River project was shut down automatically by a loop fault. The fault was traced to a large leak that had developed in the WAPD CR-VI experimental loop. Radiation surveys of the lower header room showed fields of 1000 r/hr to be present. No accompanying airborne radioactivity was found. Melting of the loop specimens in the WAPD CR-VI loop due to low flow conditions was first suspected to be the cause of the fields. Sampling of the coolant in the loop indicated that the trouble lay elsewhere. No indications of activity in the effluent cooling water and exhaust air ruled out the possibility of a normal X-rod rupture. Inspection of the Hydraulic Rabbit rod and a uranium aluminum alloy fuel rod was prompted by several radiation surveys showing high activities at these positions. These rods were removed from the reactor before the real source of trouble was located in one of the cobalt isotope tray rods (T.6). After removal, inspection of the tray rod revealed that five of the twenty-five capsules therein had their bottoms partially or totally melted off. Each of the five melted capsules contained approximately thirty grams of nickel plated cobalt pellets. The cause of the overheating and subsequent melting of the five capsules was due to a serious reduction in the cooling air flow to the samples when a valve was accidentally left open in the lower end section of the rod during the July 7 shutdown. Evidence showed that the spill took place only a few hours after the startup on July 12. Cleanup of the estimated 20,000 pellets that had escaped from the five capsules into the lower header room was initiated on July 21st and continued on until the reactor start-up on August 8, 1958. Airborne radioactivity, usually associated with cobalt spills, was non-existent. This was due to the practice

of nickel plating cobalt pellets before irradiation. An assortment of tools and methods were used to make the cobalt removal a success. Some of the more useful of these included the location of pellet sources in the headers with radiographic photographs, location of pellets on the floor utilizing beta radiation sensitive phosphor, displacement of pellets from the headers onto the floor by means of steam and water jetting, and removal of pellets to disposal flasks using vacuuming apparatus and magnets. Just prior to reactor start-up a general field of 1 r/hr persisted, arising from a few, difficult to remove sources of up to 300 r/hr in the headers. Since the field was considered to be sufficiently reduced, the reactor resumed normal operation on August 8. Cleanup of the remaining pellets in the headers was carried out during the monthly reactor shutdowns. Because of this incident all lower end sections of the tray and adjuster rods in the reactor were removed and replaced with modified end sections. (auth)

17595 (KR-41) NORA — A ZERO-POWER EXPERIMENTAL REACTOR FACILITY. NORA Project Report No. 2. E. Andersen, J. M. Doederlein, V. O. Eriksen, J. Schatvet, J. I. Wood, K. J. Oefjord (Norway. Institutt for Atomenergi, Kjeller). Jan. 1963. 33p.

A description of the NORA reactor installation is presented. The design philosophy is outlined and the facility is described in sufficient detail so that its potentialities as a reactor physics tool can be assessed. It is noted that two lattice changing systems were designed. One system consists of spacer plates with fixed holes for positioning of individual fuel stringers, and the other is based on movable fuel element supports. (J.R.D.)

17596 (LA-2833) LAMPRE I FINAL DESIGN STATUS REPORT. (Los Alamos Scientific Lab., N. Mex.). Jan. 1962. Contract W-7405-eng-36. 137p.

This report is intended to supplement LA-2327.

A description is given of LAMPRE I as it was built including preliminary operating experience of the components. (auth)

17597 (NAA-SR-Memo-7804) RELATIONSHIP OF CARBURIZING POTENTIAL TO OPERATING TEMPERATURE LIMITATIONS IN SRE. D. I. Sinizer and E. N. Pearson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). [1962]. Contract AT-11-1-GEN-8. 59p.

The effective carbon concentration of SRE sodium has now been reduced, by hot trapping, mechanical cleaning, and filtration, to a level where it will carburize Type 304 stainless steel to a surface carbon content of 0.4%. This is well below the operating limit for surface carbon, which is set at 0.5%. It is therefore recommended that the upper operating temperature limitation of 800°F at the cladding-coolant interface be removed. The cladding-coolant temperature limitation should be raised, in steps, to 930°F and then to 1060°F. The stepwise program is outlined here. With these higher temperature limitations, power level can be raised to 15 Mw, and then to 20 Mw, with a flow rate of 1400 gpm. Analysis of available information indicates that carbon in the SRE exists partially in a dissolved form, in which it is capable of carburizing stainless steel to a level dependent on time, temperature, and effective carbon level. Carbon also exists in a second phase particulate form, in which it is not available for carburizing stainless steel. Second phase carbon dissolves rapidly only when the sodium mixed mean temperature exceeds about 850°F. Therefore, most solution under present operating conditions occurs in the hot trap side stream, where the temperature reaches 1250 to 1300°F. Limiting carburization criteria are established for Type 304 stainless steel in sodium systems. If surface carbon is less than 0.5%, cladding life is infinite, from the standpoint of carburization. If surface carbon exceeds 0.5%, the limiting criterion is reached when the metallographically detectable case depth reaches 10% of the section thickness. No hazardous consequences, other than fuel element cracking under abnormal stress and operating conditions, are envisioned if carburization exceeds the established criteria. Even this condition would release no activity hazardous to operating personnel or the general public. Chemical or metallurgical analysis of grab samples from the sodium system cannot be correlated with carburizing potential of carbon in sodium, at the present time. The only method applicable, at the present time, is by monitoring the carburization of tabs in the hot trap side stream during reactor operation. Carburizing potential appears to be independent of oxygen concentration, at least to about 50 ppm. (auth)

17598 (TID-18121) LOADING CONTROL OF DRIVER ELEMENTS. A.E.T.R. CRITICAL EXPERIMENT FUEL. H. H. Stevens, Jr. (Texas Instruments Inc. M & C Nuclear Div., Attleboro, Mass.). Sept. 26, 1960. 26p.

The driver elements are 2 in. × 2 in. × 0.052 in. of 20 wt % enriched uranium in aluminum alloy. To hold the U^{235} loading of each piece within $2\frac{1}{2}\%$ of nominal requires careful control. The original plan to weigh and measure volume of each piece to determine density and loading was insufficiently accurate because of density formula variations between ingots. A second method based on counting gamma emissions was developed and the control plans based upon this method are presented. (auth)

17599 (TID-18254) SPATIALLY DEPENDENT TEMPERATURE COEFFICIENTS IN THE ATRCE CORE. A. L. MacKinney and J. W. Poston (Babcock and Wilcox Co. Critical Experiment Lab., Lynchburg, Va.). Mar. 1963. For Ebasco Services, Inc., New York. Contract AT(10-1)-1075. 41p. (ATRCE-109)

Temperature effects on reactivity caused by heating various regions of the Advanced Test Reactor Critical Experiment Core were measured by pumping heated water separately through isolated flux trap and fuel regions. The data necessary to plot reactivity as a function of temperature were obtained, and isothermal temperature coefficients were measured to correct for bulk temperature rise. As expected, the results indicated a negative temperature coefficient, −2.5¢/C, in the fuel region and a positive temperature coefficient, estimated to be +1.3¢/C, in all nine flux traps. These measurements are appropriate for a core containing six neck shim rods per neck and having the control cylinders unbalanced to approximately simulate the reference power split. (auth)

17600 (CEA-tr-A-1194) MESURES POUR DETERMINER LA DISTRIBUTION SPECTRALE DES NEUTRONS EPITHERMIQUES ET RAPIDES DANS LE COEUR ET LE REFLECTEUR D'UNE PILE PISCINE MODEREE A L'EAU LEGERE. (Measures for the Determination of the Spectral Distribution of Epithermal and Fast Neutrons in the Core and Reflector of Pool-Type Reactors Moderated by Light Water). W. Koehler (Munich. Technische Hochschule). Translated into French. [1961]. 25p.

The most recent measurements on the spectral distribution of epithermal and fast neutrons in the core and moderator of a swimming pool reactor are reported and compared with calculations and measurements made by other investigators. The results are shown in graphical form. (J.S.R.)

17601 SOME ASPECTS OF THE CONSTRUCTION OF THE NUCLEAR REACTOR BR-2. [PART] II. ACEC Rev., No. 3, 18-37(1962). (In French)

The description of the construction of the BR-2 reactor is concluded with a consideration of the control rods, nuclear control installation, pumps of primary system, and the auxiliary power supply. The descriptions are supplemented by photographs and cross sections. (J.S.R.)

17602 THE TRANSFER OF JASON. K. G. Stephens and D. R. Chick. Nucl. Energy, 92-5(Mar. 1963).

A description is given of the Jason research reactor and the operations underwent in its transfer from Langley to Greenwich. The modifications made in the reactor and in the new site are described. The commissioning steps are outlined, and criticality was achieved 18 months after the last operational run at Langley ($6\frac{1}{2}$ months after the start of reactor assembly at Greenwich). (D.L.C.)

SPACE APPLICATIONS AND TECHNOLOGY

Refer also to abstract 16881.

17603 (JPL-TR-32-233) FEASIBILITY OF INTERSTELLAR TRAVEL. Dwain F. Spencer and Leonard D. Jaffe (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Mar. 15, 1962. Contract NAS 7-100. 19p. (N62-11503)

The feasibility of interstellar flight is discussed. Mathematical equations for single-stage and multistage rocket propulsion are developed, velocity data and transit times are presented, and mass ratios required for fission and fusion rockets are given. The conclusions indicate that interstellar travel is theoretically feasible by utilizing known staged nuclear-energy systems. (auth)

17604 (N62-11122) DESIGN, FABRICATION, AND TESTING OF A CESIUM ION ROCKET ENGINE. Quarterly Progress Report No. 2, December 1, 1960 through February 28, 1961. (Hughes Research Labs. Div. of Hughes Aircraft Co., Malibu, Calif.). Contract NAS5-517). 91p.

A description of Cs ion engine development work on a hollow-beam system to be used in a series of flight tests is given. Several ion engines were assembled during the period and tests were carried out on these units until leaks prevented further work. Work was continued on neutralization research, ionizer physics studies, ionizer heating and shielding techniques, laboratory propellant feed system design and testing, electrode design, and test facility development. (J.R.D.)

17605 (N62-11311) A STUDY OF SYSTEMS FOR SPACE PROPULSION. Quarterly Progress Report No. 6, May 1 to July 31, 1962. (Stanford Univ., Calif. Microwave Lab.). Aug. 1962. Contract NAS 8-1509. 11p. (ML-947)

An analytical evaluation of possible space-charge solutions suitable for use in ion guns is presented. Particular emphasis was placed upon accel-decel curvilinear configurations using conical or cylindrical ion emitter designs and yielding an almost parallel beam. Emitter current densities of at least 5 ma/cm^2 were considered. An evaluation of electrode geometries of minimum ion interception characteristics, studies of the electron-ion mixing process, and examination of various solutions for possible electron trapping regions which would facilitate beam neutralization were conducted. (H.G.G.)

17606 (NASA-TN-D-1578) FEASIBILITY OF OPTIMIZING NOZZLE PERFORMANCE FOR ORBITAL-LAUNCH NUCLEAR ROCKETS. John R. Jack (National Aeronautics and Space Administration. Lewis Research Center, Cleveland). Apr. 1963. 25p.

Conclusions were drawn concerning optimum values of nozzle area ratio and operating pressure and operating conditions for favorable nozzle heat transfer. In general, the nozzle efficiency increases with both increasing divergence angle and increasing stagnation pressure level. For a given set of conditions, however, the nozzle efficiency increases with increasing area ratio only until the gains in performance due to additional expansion are offset by the increase in convective heat transfer. The variation of specific impulse with pressure is maximized at a pressure level that depends upon the pressure at which the flow freezes. On the basis of heat transfer, operation on the low-pressure side of the optimum point is desirable because a substantial reduction in the throat heat flux is thereby permitted. (auth)

17607 RADIONUCLIDE POWER FOR SPACE. PART 2. ISOTOPE-GENERATOR RELIABILITY AND SAFETY. D. G. Harvey, P. J. Dick, and C. R. Fink (Martin Co., Baltimore). Nucleonics, 21: No. 4, 56-9(Apr. 1963).

The operating experience of SNAP devices in the Transit 4A and 4B satellites is described. Only two power excursions were observed which are probably due to a capacitor failure in the power conditioning system. The results and tests indicate that the reliability of the generator unit and thermoelectric couples will be satisfactory. Exhaustive proof testing has shown that containment of the radioactive fuel can be absolutely guaranteed during the launch and that the fuel will burn up on re-entry at orbital velocities. The possibility of only partial burnup at suborbital velocities is an improbable one. (D.L.C.)

17608 A NUCLEAR REACTOR FOR THE ENERGY REQUIREMENTS OF ELECTRIC PROPULSION. K. H. Hoecker, H. Unger, G. Kuerz, and R. Pruschek (Technische Hochschule, Stuttgart). Raketentech. Raumfahrtforsch., 7: 1-5(Jan.-Mar. 1963). (In German)

The fundamentals of neutron physics and heat transmission for the design of a nuclear power plant which should generate electricity under space conditions are shown and discussed by means of an example. The conversion of heat to electricity is performed directly by thermionic energy transducers, rather than by application of the convectional Rankine or Brayton cycle. (auth)

17609 NUCLEAR ROCKET REACTOR ANALYSIS. Robert W. Deutsch. Preprint Paper No. 63-68. New York, Institute of the Aerospace Sciences, 1963. 37p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

A description is presented of the analytical and experimental procedures used to determine the physics and engineering information required for reactor core and shield design. Nuclear characteristics including control range, transient response, and safety requirements are described. Application of present reactor design techniques to the development of large nuclear propulsion systems is discussed. (auth)

17610 ADVANCES IN SPACE SCIENCE AND TECHNOLOGY. VOLUME 4. Frederick I. Ordway, III, ed. New York, Academic Press, 1962. 441p. $14.00.

Six papers are included; a separate abstract has been prepared for 1 of these. The remaining five papers cover such topics as Doppler effects in artificial satellites, extraterrestial intelligence, multiple-stage carrier development, space vehicle entry and landing in planetary atmospheres, and the development of manned artificial satellites and space stations. (T.F.H.)

17611 ON THE UTILIZATION OF RADIOACTIVE ELEMENTS AS ENERGY SOURCES FOR SPACECRAFT PROPULSION. J. J. Barré. p.319-409 of "Advances in Space Science and Technology." Volume 4. Frederick I. Ordway, III, ed. New York, Academic Press, 1962. $14.00.

The classification, production, and properties of "radiergols" (energy-liberating-radionuclides) are reviewed and tabulated. The domain and limits of radiergol propulsion are delineated. Radiothermal and radionic types of engines using radiergols are described as examples. (T.F.H.)

17612 VEHICLE DESIGN CONSIDERATIONS. Arthur J. Steele and H. F. Plank. Preprint Paper No. 63-69. New York, Institute of the Aerospace Sciences, 1963. 22p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

A few of the influences of the presence of a nuclear rocket engine on the design of a nuclear stage were discussed. Propellant container and structure, flight control systems, and propellant pressurization system design were considered. (C.E.S.)

17613 REUSEABLE-MANNED-NUCLEAR ORBITAL CARRIER. R. L. Gervais, G. Markus, and R. G. Riedesel. Preprint Paper No. 63-32. New York, Institute of the Aerospace Sciences, 1963. 54p. $1.00.

Paper from 31st Annual Meeting, New York, Jan. 1963.

Vehicle design and system concepts for large-scale transportation of cargo and personnel in support of manned orbital and lunar activities was described. The inherent advantages of nuclear propulsion were incorporated into the investigation. Crew and passenger safety were used as general design guidelines. Methods of optimizing payload, reactor power management, and vehicle design were discussed within the restrictions imposed by man, a reactor, and recovery techniques. (C.E.S.)

WASTE DISPOSAL AND PROCESSING

17614 (CEA-2195) STATION DE TRAITEMENT DES DECHETS RADIOACTIFS SOLIDES AU CENTRE D'ETUDES NUCLEAIRES DE SACLAY. (A Treatment Station for Solid Radioactive Waste at the Saclay Nuclear Research Center). P. Cerre, E. Mestre, and P. Lebrun (France. Commissariat à l'Energie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 37p.

The waste from an atomic center is very varied in nature, in form, and in activity, going from weakly contaminated laboratory waste to objects actuated in a pile and strongly radioactive. After one year's working of a pilot plant, a factor was built in which solid waste is treated and then conditioned in concrete blocks. The treatment and conditioning techniques in this factory which uses to a maximum remotely controlled operation are described. (auth)

17615 (HW-76262) RESEARCH AND DEVELOPMENT ACTIVITIES— FIXATION OF RADIOACTIVE RESIDUES. Quarterly Progress Report, October–December 1962. E. R. Irish, ed. (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Jan. 1963. Contract AT(45-1)-1350. 42p.

A radiant-heat calciner and melt-pot calciner were used to process full-level Purex 1 WW in continued experimental studies. Sugar was found to have a suppressing effect on Ru volatility. Continued development work is reported on in-tank solidification of bulk salt waste and packaging of radiocesium and ratiostrontium concentrates. In sorption and extraction studies, a part of the ternary equilibrium system Cs–H–Na was determined for clinoptilolite. The effects of temperature on mass action quotients were evaluated for the Cs–Na system for seven zeolites. Two additional runs were made in a micro pilot plant with Purex condensate to evaluate mixed ion exchange decontamination. The effects of particle size, flow rate, and temperature on Sr adsorption by Linde 4A zeolite were studied. Loading rates are significantly increased at elevated temperatures without capacity loss. Developmental studies were continued toward use of D2EHPA solvent extraction flowsheet for removal of Sr and rare earths from Purex FTW. (J.R.D.)

17616 (IDO-14596) DESIGN OF A PILOT PLANT FACILITY FOR RADIOACTIVE DEMONSTRATION OF THE POT CALCINATION PROCESS. B. R. Wheeler and J. A. Buckham (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 14, 1962. Contract AT(10-1)-205. 109p.

Based on process development work at ORNL, a facility was designed for demonstration of the pot calcination process with a variety of high-level radioactive wastes. In this facility, operational and control problems associated with an integrated process can be identified and solved, procedures to improve characteristics of the calcine can be studied, and important aspects of calcine temperature distribution and fission product behavior can be observed. Installation of the facility is planned for the Hanford Atomic Products Operation. The facility can be installed in any cell or cells having certain basic features. (auth)

17617 (LADC-5366) EVALUATION OF TEMPERATURE RISES IN RADIOACTIVE WASTES. E. F. Gloyna (Texas. Univ., Austin); H. J. Longley, and C. W. Christenson (Los Alamos Scientific Lab., N. Mex.). [1962]. Contract W-7405-eng-36. 36p.

Generalized numerical and analytical methods were developed for estimating rises in temperatures resulting from the storage of high-level wastes. Parametric relations were considered, and solutions for the packed-bed, multiregion, variable-geometry, and variable-effective thermal conductivity system were evaluated. Solutions of the heat equation in one space dimension were obtained for plane, cylindrical, and spherical geometries. Temperature and time-dependence examples involving effective thermal conductivities were solved. The accuracy of the solutions depends chiefly on the values of the input data and the variations of the parameters affecting the finite mesh and boundary conditions. The size of storage sites, concentration of wastes, and age of wastes have the greatest effect on the magnitude of the temperature. Three codes were developed, tested for accuracy, and compared. The codes represent three approximations to the actual physical situation. An auxiliary code was written to provide an estimate of the waste that could be put into a cavity when a maximum permissible temperature is specified. (auth)

17618 (ORNL-TM-263) THE USE OF PHOSPHITE AND HYPOPHOSPHITE TO FIX RUTHENIUM FROM HIGH-ACTIVITY WASTES IN SOLID MEDIA. H. W. Godbee and W. E. Clark (Oak Ridge National Lab., Tenn.). June 19, 1962. Contract [W-7405-eng-26]. 18p.

Fission product Ru, normally volatile to the extent of 20 to 60% in evaporation and calcination of simulated high level radioactive wastes at 500 to 1000°C, can be 99.9% retained in the solid product by addition of 2 moles of phosphite or hypophosphite per liter of waste. As little as 0.1 mole per liter lowered the Ru volatility during distillation approaching equilibrium by factors which varied from 38 for Darex to 225 for TBP-25 (aluminum) waste solutions. The final products with Purex, TBP-25, and Darex (stainless steel) wastes were insoluble glassy solids with densities of 2.4 to 3.8 g/ml and represented volume reductions of 2.9 to 8. These volume reductions are essentially the same as those obtained when the waste is calcined without additives. (auth)

17619 (ORNL-TM-482) WASTE TREATMENT AND DISPOSAL QUARTERLY PROGRESS REPORT, AUGUST–OCTOBER 1962. R. E. Blanco and F. L. Parker (Oak Ridge National Lab., Tenn.). Mar. 25, 1963. Contract [W-7405-eng-26]. 90p.

Progress on waste treatment and disposal is reported. Topics covered include: high-activity-waste calcination, design of pilot plant, fixation of waste in glass, low-activity-waste treatment, engineering, economics, safety evaluation, disposal by hydraulic fracturing, disposal in natural salt formation, Clinch River study, fundamental studies of minerals, White Oak Creek basin study, and foam separation. (M.C.G.)

17620 (EURAEC-518) RESEARCH ON THE TREATMENT OF WATER AND RADIOACTIVE RESIDUES. Quarterly Report No. 11, October 1–December 31, 1962. (Mol, Belgium. Centre d'Etude de l'Energie Nucléaire). Work Performed under United States–Euratom Joint Research and Development Program. Contract 048-61-4-RDB. 36p. A translation.

Three phases of research on the treatment of water and radioactive wastes by the Centre de l'Energie Nucléaire in Belgium during Oct. to Dec. 1962 are discussed. These

phases are: insolubilization by embedding in asphalt, study of soils by injection of radioisotopes and fluctuation of the underground water meteorological observations, and incineration of radioactive waste and combustion gas analysis. Quarterly progress of these three phases was discussed. (H.G.G.)

17621 RADIOACTIVE WASTE DISPOSAL PLANT IN THE INSTITUTE OF NUCLEAR RESEARCH OF THE CZECHOSLOVAK ACADEMY OF SCIENCES. Vladimír Veselý (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Prague), Aloís Jenícek, and Josef Drahozal. Jaderna Energie, 9: 3-7(1963). (In Czech)

A disposal plant for radioactive wastes built in Řež is described. The purpose of the plant, its capacity, the processes used, and constructional lay-out of the building are explained. (P.C.H.)

CORPORATE AUTHOR INDEX

This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt." This change permits a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

A

AEROJET-GENERAL NUCLEONICS, SAN RAMON, CALIF.

Corrosive effects of Rb on alloys from 1000 to 2000° F, 17: 16634 (AGN-8063)

Prog. rpt. on electrodeless pulse plasma propulsion, final, 7/61–11/62, 17: 16771 (ASD-TDR-62-1105)

Prog. rpt. on GCR reactor systems, 7/12/62, 17: 17541 (IDO-28602)

Prog. rpt. on Rb/Cs evaluation, 10-12/62, 17: 16768 (AGN-8075)

AIR FORCE TECHNICAL APPLICATIONS CENTER, WASHINGTON, D. C.

Seismic measurements of Stoat, 17: 16262 (AD-297344)

AKTIEBOLAGET ATOMENERGI, STOCKHOLM.

Anion-exchange of radioactive trace elements in H_2SO_4, 17: 16138 (AE-103)

Bibliography on corrosion of stainless steel, 17: 16593 (VDIT-5a)

Bibliography on extraction of U, 17: 16147 (VDIT-68)

Bibliography on separation of U(VI) from aqueous solutions, 17: 16148 (VDIT-70)

Computations for circular radiator and circular detector, 17: 16943 (AE-101)

Coordinate index to bibliography on radiation effects on U-based fuel materials, 1961–62, 17: 16747 (VDIT-16(Ind.61/62))

Irradiation modifications in reactor pressure vessels, 17: 16732 (AES-2)

ALLIS-CHALMERS MFG. CO., MILWAUKEE.

Boron stainless steel control rods for Pathfinder, 17: 17531 (ACNP-63001)

Prog. rpt. on Pathfinder, 7–9/62, 17: 17529 (ACNP-62034)

ALLIS-CHALMERS MFG. CO. ATOMIC ENERGY DIV., WASHINGTON, D. C.

Burst slug detection equipment shield analysis for EGCR, 17: 17562 (TID-18241)

Burst slug detection system for EGCR, 17: 17563 (TID-18242)

Burst slug detection system for EGCR, 17: 17530 (ACNP-62509)

Cooling requirements for fuel assemblies, EGCR, 17: 17552 (TID-18101)

Core gas seals, EGCR, 17: 17551 (TID-18099)

Core structure and bottom plate for EGCR, 17: 17565 (TID-18244)

Design of core peripheral restraints for EGCR, 17: 17557 (TID-18235)

Design of top grid structure for EGCR, 17: 17558 (TID-18237)

Design requirements for EGCR core structure, 17: 17560 (TID-18239)

Dummy fuel assemblies for EGCR, 17: 17567 (TID-18247)

EGCR temperature distributing moderator and reflector, 17: 17559 (TID-18238)

Fast neutron leakage, EGCR, 17: 17554 (TID-18106)

Gamma heating core structure metallic components, EGCR, 17: 17547 (TID-18095)

Graphite core structure for EGCR, 17: 17571 (TID-18251)

Instrumentation for fuel column, EGCR, 17: 17553 (TID-18102)

Neutron flux distributions in EGCR, 17: 17566 (TID-18245)

Neutron streaming from EGCR core, 17: 17548 (TID-18096)

Pneumatic temperature monitoring system for EGCR, 17: 17561 (TID-18240)

Radial fast neutron leakage from EGCR, 17: 17564 (TID-18243)

Reactor core and coolant flow for EGCR, 17: 17568 (TID-18248)

Shear test of AGOT graphite, 17: 16659 (TID-18246)

Shielding analysis of service machine, EGCR, 17: 17549 (TID-18097)

Temperature distribution moderator and reflector core, EGCR, 17: 17550 (TID-18098)

Thermal columns and access tubes for EGCR, 17: 17569 (TID-18249)

Vessel, core and control rod alignment of EGCR, 17: 17570 (TID-18250)

AMES LAB., AMES, IOWA.

Injection of electrons into annular machines. II., 17: 17312 (IS-522)

AMF ATOMICS. DIV. OF AMERICAN MACHINE AND FOUNDRY CO., GREENWICH, CONN.

On-power refueling system, Douglas Point Plant, 17: 17532 (AMF-388-TR-2(Vol. I))

On-power refueling system, Douglas Point Plant, 17: 17533 (AMF-388-TR-2(Vol. II))

ARGONNE NATIONAL LAB., ILL.

Computers in experimental physics, 17: 16789 (TID-18145)

Copper spark method for spectrographic analysis, 17: 15934

Decomposition of PuF_6 by radiation, 17: 16045 (TID-18184)

Fabrication of EBR-II Core I fuel elements, 17: 16602 (ANL-6276)

Fabrication of fuel and blanket for AFSR, 17: 17591 (ANL-6107)

Fabrication procedures for high-quality tubing, 17: 16603 (ANL-FGF-409)

Facility 350 He–atmosphere system, 17: 16171 (ANL-6489)

Magnetic resonance studies of acidic organophosphorus compounds, 17: 16034 (TID-18170)

Matrix representation of detection systems, 17: 16429 (TID-18304)

Multichannel pulse-height analyzer, 17: 16428 (TID-18153)

Optical rotatory dispersion of amino acids, 17: 16032 (TID-18142)

Proceedings of AMU-ANL summer study program, 6/19–7/14/61, 17: 17403 (ANL-6640)

Prog. rpt. on physics, 11-12/62, 17: 16770 (ANL-6666)

Reactor Fuel Processing, Vol. 6, No. 1, 17: 17449

Results from Fricke diffusion kinetics code, 17: 16502 (ANL-6560)

Review of ANL radiation exposure experience, 1959–1961, 17: 16312 (ANL-6688)

Uranium–oxygen bonding in uranates, 17: 15959 (TID-18140)

Visit to Soviet corrosion chemistry institutes, 6/25–7/4/62, 17: 16592 (TID-17940)

ARMED FORCES INST. OF PATHOLOGY, WASHINGTON, D. C.

Effects of irradiated pork diet, 17: 16366 (NP-12604)

Effects of irradiated carrot diet, 17: 16367 (NP-12605)

Effects of irradiated dog food, 17: 16368 (NP-12606)

Effects of irradiated food, 17: 16369 (NP-12607)

Effects of irradiated dog food, 17: 16370 (NP-12608)

Effects of irradiated orange diet, 17: 16371 (NP-12609)

ARMY MEDICAL RESEARCH AND NUTRITION LAB., DENVER.

Prog. rpt. on wholesomeness of irradiated diet, 3–9/62, 17: 16365 (NP-12603)

ASSOCIATED TESTING LABS., INC., WAYNE, N. J.

Seal test for EGCR charge machine blister drives, 1/9/63, 17: 17427 (TID-18234)

Seal test for EGCR charge machine blister drives, 11/7/62, 17: 16180 (TID-18233)

ATOMIC ENERGY OF CANADA LTD., CHALK RIVER, ONT.

Attapulgus clay for organic coolant purification, 17: 15849 (CRCE-1131)

Coefficients for angular correlation in nuclear bombardment, 17: 17104 (CRP-615(Rev.))

Irradiation of Zy-2 clad UO_2, 17: 16735 (EXP-NRX-2807)

Photoelastic study of metallic seals, 17: 16170 (AECL-1662)

Physics of D_2O lattices, 17: 17402 (AECL-1684)

Radiation biology in Canada 1962-63, 17: 15627 (CRB-1129)

Strontium, Ba and Ca in human diet, 17: 15587 (CRER-1068)

ATOMIC ENERGY OF CANADA LTD. CHALK RIVER PROJECT, CHALK RIVER, ONT.

Cobalt spill at NRX, 7/58, 17: 17594 (IOI-158)

Spherical harmonics method for thermal utilization in cylindrical cells, 17: 17089 (CRT-1088)

ATOMICS INTERNATIONAL. DIV. OF NORTH AMERICAN AVIATION, INC., CANOGA PARK, CALIF.

Bibliography on kinetics, stability, and control, 17: 17420 (NAA-SR-7786)

Effect of gas content on ONB point for Santowax OM + 30 w/o HB, 17: 16228 (NAA-SR-Memo-8064)

Effective radius of control rods, 17: 17421 (NAA-SR-Memo-477)

Electromagnetic pumps for Na service, 17: 16176 (NAA-SR-Memo-7955)

FORTRAN SNG code, 17: 16507 (TID-18116)

Four-group cross sections, 17: 17422 (NAA-SR-Memo-7789)

Fuel-handling heat transfer analysis, 17: 17545 (NAA-SR-Memo-8053)

Nuclear safety in Hallam UC fuel shipment, 17: 16317 (NAA-SR-Memo-8151)

Prog. rpt. on thermionic energy conversion, 11/61–10/62, 17: 16769 (AI-7979)

Pyrolytic capsule fouling test, 17: 17423 (NAA-SR-Memo-8088)

Recovery of electrical resistivity of cold-worked Th, 17: 16651 (NAA-SR-Memo-1522)

Reflected reactor kinetics, 17: 16940 (NAA-SR-7263)

Relationship of carburizing potential to operating temperature limitations in SRE, 17: 17597 (NAA-SR-Memo-7804)

SAIL—NAA program description, 17: 17093 (TID-18117)

Sodium-reactor development program, 17: 17542 (NAA-SR-3740)

Spiral boiler evaluation, 17: 16227 (NAA-SR-Memo-7945)

Standardization of γ PHA calculations at OMRE, 17: 17543 (NAA-SR-Memo-7521(Rev.))

Two-zone core temperature for PNPF, 17: 17544 (NAA-SR-Memo-7952)

Uranium carbide and cladding materials for Na-cooled reactors, 17: 16650 (NAA-SR-7696)

Uranium–Mo alloy fuel costs, 17: 16521 (NAA-SR-Memo-2974)

AUSTRALIA. ATOMIC ENERGY COMMISSION RESEARCH ESTABLISHMENT, LUCAS HEIGHTS, NEW SOUTH WALES.

Calculation of crystal and counter settings for collection of crystallographic data, 17: 15936 (AAEC/TM/179)

Crystallographic structure factor program for IBM 1620 computer, 17: 16767 (AAEC/TM-180)

B

BABCOCK AND WILCOX CO., LYNCHBURG, VA.

Pile oscillator experiments with ATRCE, 17: 16942 (TID-18064)

Temperature coefficients in ATRCE Core, 17: 17599 (TID-18254)

BADGER METER MFG. CO., MILWAUKEE.

Prog. rpt. on densitometer for He–graphite or N–graphite flow streams, 8–10/62, 17: 16386 (TID-18162)

BATTELLE MEMORIAL INST., COLUMBUS, OHIO.

Annealing studies on irradiated type 347 stainless steel, 17: 16733 (BMI-1621)

Enhanced catalytic activity from irradiation of catalysts, 17: 16040 (BMI-1620)

Fission-product migration in and release from Fe–20 wt % Cr, 17: 16638 (BMI-1611)

Prog. rpt. on civilian applications, 12/62, 17: 15532 (BMI-1607(Del.))

Reactor Materials, Vol. 6, No. 1, 17: 17442

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DMIC selected accessions, 2/63, 17: 16523 (NP-12632)

Fracture toughness of stainless steels, 17: 16640 (DMIC-Memo-164)

Tensile properties of W, 17: 16639 (DMIC-Memo-157)

Uses for depleted U and nonenergy uses for natural U, 17: 16515 (DMIC-Memo-165)

BRANDEIS UNIV., WALTHAM, MASS.

Properties of vertex functions in strong interactions, 17: 16954 (NP-12644)

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DYNAPAK extrusion of I & E fuel elements, 17: 16604 (BRB-69)

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Cherenkov and scintillation properties of Plexiglas UVT and UVA, 17: 16418 (BNL-6865)

Fast analysis system for bubble chamber data, 17: 16419 (BNL-6871)

Fundamentals of vacuum technology, 17: 16172 (BNL-6796)

Heat transfer to Hg flowing in-line through bundle of circular rods, 17: 16222 (BNL-6826)

Magnet design suggestions, 17: 17310 (BNL-6844)

Neutron scattering law and neutron thermalization, 17: 17088 (BNL-770)

Prog. rpt. on reactor science and engineering, 10–12/51, 17: 17404 (BNL-164)

Radiation effects on maize, 17: 15626 (BNL-6027)

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Delay apparatus, type II, 17: 16503 (BLG-134)

Prog. rpt. on corrosion problems, 1–3/60, 17: 16594 (EURAEC-29)

Prog. rpt. on production of Zr alloy powders, final, 12/16/61–7/15/62, 17: 16529 (EURAEC-509)

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Prog. rpt. on corrosion problems, 1–3/60, 17: 16594 (EURAEC-29)

Prog. rpt. on steel corrosion in high-temperature H_2O and steam, 10–12/63, 17: 16595 (EURAEC-552)

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C

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Binary alloys of rare earth metals with Au and Ag, 17: 16658 (TID-18197)

Interstellar travel, 17: 17603 (JPL-TR-32-233)

CALIFORNIA. UNIV., BERKELEY.

Crystal structure of $Eu_2(WO_4)_3$, 17: 16663 (UCRL-10344)

Measurement of electric charge renormalization, 17: 16958 (UCRL-10336)

Transition in Yb, 41 kilobar, 17: 16662 (UCRL-10332)

CALIFORNIA. UNIV., BERKELEY. INST. OF ENGINEERING RESEARCH.

Analysis of stress concentrations in thin spherical shells, 17: 16664 (UCRL-13064)

Transient stress distribution in rapidly heated rod, 17: 16260 (HE-150-210)

CALIFORNIA. UNIV., BERKELEY. LAWRENCE RADIATION LAB.

Argon–He scintillation, 17: 16794 (UCRL-10523)

Crystal structure of $Eu_2(WO_4)_3$, 17: 16663 (UCRL-10344)

Downflow boiling of n-butanol, 17: 16234 (UCRL-10527)

East-west asymmetry in geomagnetically trapped protons, 17: 16918 (UCRL-10587)

Measurement of electric charge renormalization, 17: 16958 (UCRL-10336)

Mössbauer effect in Dy-161, 17: 17130 (UCRL-10630)

Transition in Yb, 41 kilobar, 17: 16662 (UCRL-10332)

CALIFORNIA. UNIV., LIVERMORE. LAWRENCE RADIATION LAB.
Analysis of stress concentrations in thin spherical shells, 17: 16664 (UCRL-13064)
Fission cross section of U-235, 17: 17129 (UCRL-6926)
Fission distribution in cluster fuel elements, 17: 17128 (UCRL-6695)
Inverted cascades in neutral injection systems, 17: 17342 (UCRL-7115)
Prog. rpt. on hazards control, 7–9/62, 17: 16332 (UCRL-7143)
Transient stress distribution in rapidly heated rod, 17: 16260 (HE-150-210)

CALIFORNIA. UNIV., LOS ANGELES.
Apochlorosis and photoreactivation in Euglena, 17: 15640 (TID-18203)
High-energy cyclotron to accelerate H^- ions, 17: 17319 (TID-18223)
Liver blood flow estimates, 17: 15543 (UCLA-511)

CALIFORNIA. UNIV., RICHMOND. INST. OF ENGINEERING RESEARCH.
Gamma intensity in presence of shielding, 17: 17393 (NP-12611)

CARNEGIE INST. OF TECH., PITTSBURGH.
Prog. rpt. on radiation effects on solids, 4/62–3/63, 17: 16746 (TID-18253)

CAROLINAS VIRGINIA NUCLEAR POWER ASSOCIATES, INC., COLUMBIA, S. C.
Effects of irradiation on pressure tube material, 17: 16734 (CVNA-159)

CASE INST. OF TECH., CLEVELAND.
Apparatus for study of primary processes in radiation chemistry, 17: 16044 (TID-18144)

CENTRAL UTILITIES ATOMIC POWER ASSOCIATES.
Boron stainless steel control rods for Pathfinder, 17: 17531 (ACNP-63001)
Prog. rpt. on Pathfinder, 7–9/62, 17: 17529 (ACNP-62034)

CENTRO INFORMAZIONI STUDI ESPERIENZE, MILAN.
Prog. rpt. on application of steam–H_2O spray to reactor cooling, 10–12/62, 17: 17406 (EURAEC-519)
Prog. rpt. on application of steam–H_2O spray to reactor cooling, 10–12/62, 17: 17407 (EURAEC-537)

CHICAGO. UNIV.
Crystal structure of beta Pu metal, 17: 16648 (LADC-5373)
Polarographic oxidation potentials of aromatic compounds, 17: 16033 (TID-18149)

CLARK UNIV., WORCESTER, MASS.
Analytical chemistry of alkaline earths, 17: 16055 (TID-18261(p.71-2))
Fission of light elements, 17: 16053 (TID-18261(p.49-60))
Fission of rare earth elements, 17: 16052 (TID-18261(p.44-8))
Isomeric cross-section ratios for $Te^{130}(p,pn)$ and $Te^{128}(p,pn)$ reactions, 17: 16049 (TID-18261(p.19-23))
Isomeric ratios in $Nb^{93}(\alpha,xn)$ reactions, 17: 16047 (TID-18261(p.1-14))
Isomeric ratios in nucleon-transfer reactions, 17: 16050 (TID-18261 (p.24-6))
Low-level applications of solid-state detectors, 17: 16056 (TID-18261 (p.73-4))
Prog. rpt. on chemistry, annual, 1/31/63, 17: 16046 (TID-18261)
Recoil studies of U fission fragments, 17: 16051 (TID-18261(p.27-43))
Studies of Ce^{137m}/Ce^{137} isomeric ratio formed from Ce^{140}, 17: 16054 (TID-18261(p.61-70))
Studies of $In^{115}(\alpha,2p)In^{117}$ reaction, 17: 16048 (TID-18261(p.15-18))

COMBUSTION ENGINEERING, INC., WINDSOR, CONN.
Prog. rpt. on burnable poison additions to UO_2, 12/62, 17: 16605 (CEND-173)

CORNELL UNIV., ITHACA, N. Y.
Effects of irradiated dog food, 17: 16370 (NP-12608)

D

DEL ELECTRONICS CORP., MOUNT VERNON, N. Y.
Prog. rpt. on stratospheric monitoring, 12/60–1/61, 17: 16319 (NYO-9674)
Prog. rpt. on stratospheric monitoring, 2/61–4/62, 17: 16320 (NYO-9675)

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Prog. rpt. on oxidation of beryllides, 12/62–3/63, 17: 15947 (DRI-2088)

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Effective cross sections for bremsstrahlung and pair production, 17: 17105 (DESY-A-2.96)

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Bibliography on radionuclides and ionizing radiation in ornithology, 17: 15635 (TID-17762)

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Survey of 21 reactor vessels, 17: 16743 (TID-17682)

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Activation analysis of ocean bottom cores, 17: 15886 (TID-18125)
Sediment density meter, 17: 16372 (TID-18124)

DU PONT DE NEMOURS (E. I.) & CO. SAVANNAH RIVER LAB., AIKEN, S. C.
Hazards evaluation of HWCTR, 17: 17592 (DP-600)
Hydride orientation control in Zy-2, 17: 15958 (TID-16476)
Low-temperature still for separation of H isotopes, 17: 16490 (DP-732)
Metallographic preparation of Zy-2, 17: 16656 (TID-16475)
Pilot plant for processing irradiated nuclear fuel, 17: 16140 (DP-757)
Purification of H-3 by electrolysis, 17: 16489 (DP-261)
Resonance integrals and self-shielding factors for detector foils, 17: 17106 (DP-817)
Sulfamic acid for dissolving Pu, 17: 15957 (TID-16387)

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Prog. rpt. on PWR operations, 1/63, 17: 17534 (DLCS-5000163)

E

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Seal test for EGCR charge machine blister drives, 1/9/63, 17: 17427 (TID-18234)
Seal test for EGCR charge machine blister drives, 11/7/62, 17: 16180 (TID-18233)

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Pile oscillator experiments with ATRCE, 17: 16942 (TID-18064)

EDGERTON, GERMESHAUSEN AND GRIER, INC., SANTA BARBARA, CALIF.
Prog. rpt. on thermoluminescent dosimeter, final, 7/3–9/3/61, 17: 16416 (AD-283918L)

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Radiation damage in muscle cell membranes, 17: 15641 (TID-18221)

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Transmission through linear magnetic system of beam of primary particles, 17: 16944 (CERN-62-36)

F

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Prog. rpt. on fission gas release from UO_2, 10-12/62, 17: 16645 (EURAEC-568)
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17: 17408 (EURAEC-584)

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High-resolution spectroscopy of Pu. I and II., 17: 15946 (CEA-2238)

Nuclear magnetic resonance in ferromagnets, 17: 16772 (CEA-2213)

Safety precautions in pile control, 17: 17405 (CEA-2174)

Short luminous pulses and application to scintillation phenomena, 17: 16421 (CEA-2194)

Transistorized pulsed amplifiers, 17: 16381 (CEA-1932)

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FRANKLIN INST., PHILADELPHIA.

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G

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Activation of Th-232 resonance captures in prototype HTGR, 17: 17107 (GA-3069)

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Calculation of line widths, 17: 17324 (GAMD-927)

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In-core power monitoring of reactors, 17: 17410 (GEAP-3914)

Irradiation of reactor control materials, 17: 16737 (GEAP-3927)

Isotopic analysis of UO_2 fuel irradiated in VBWR, 17: 16739 (GEAP-4107)

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Vibration of fuel rods in parallel flow, 17: 17537 (GEAP-4059)

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Burst test unit for irradiated pressure tubes, 17: 16740 (HW-76158)

Drive for pumps of large reactor, 17: 17414 (HW-SA-2922)

Fretting corrosion of Zy-2 clad thermocouples, 17: 16588 (HW-75626)

Glove box design for Pu reclamation facility, 17: 16141 (HW-68442)

Instrumentation and control of in-reactor test facility, 17: 17593 (HW-SA-2945)

Problems in reactor theory and electrical engineering, 17: 17415 (HW-SA-2933)

Prog. rpt. on fuel re-use, 17: 17413 (RW-74549)

Prog. rpt. on metallurgy, 10-12/62, 17: 16741 (HW-76228)

Prog. rpt. on radioactive residues, 10–12/62, 17: 17615 (HW-76262)

Radioisotopic heat sources, 17: 16357 (HW-76323)

Transients following He line failure at PRTR pressurizer, 17: 17540 (HW-75731)

Utilization of Pu for special reactor applications, 17: 16517 (HW-SA-2872)

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Effects of tests in USGS Tunnel, NTS, 17: 15540

Evaluating discordant Pb-isotope ages, 17: 16308

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Pneumatic pressure lag. I., 17: 16232 (TID-16555)

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H

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Prog. rpt. on diffusion of rare gases in solids, 12/11/61–10/12/62, 17: 16665 (EURAEC-363)

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I

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Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16364 (NP-12602)

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Prog. rpt. on improved Zr alloys, 10–12/62, 17: 16582 (ARF-B198-36)
Prog. rpt. on magnetic properties of insulators, 11/16/62–2/15/63, 17: 15942 (ARF-1184-8)
Prog. rpt. on measurement of capture γ rays from elements, 11/62–1/63, 17: 15943 (ARF-1193-20)
Prog. rpt. on preparing high specific activity radioisotopes, 17: 16356 (ARF-1207-9)
Prog. rpt. on V alloys, 12/14/62–2/13/63, 17: 16514 (ARF-B6007-1)

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Formation of point defects during plastic deformation, 17: 16657 (TID-16506)
Lattice point defect configurations, 17: 15956 (TID-16340)
Prog. rpt. on computers, 1/63, 17: 16508 (TID-18236)
Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16359 (NP-12596)
Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16364 (NP-12602)
Radiation effects on maize, 17: 15626 (BNL-6027)

INDIA. ATOMIC ENERGY ESTABLISHMENT, TROMBAY.
Apparatus for fine-particle measurement, 17: 15937 (AEET/CD/4)
Determination of particle size of ThO_2 powders, 17: 15938 (AEET/CD/5)
Estimation of T by gas-phase counting, 17: 15871 (AEET/HP/TM-10)
Prog. rpt., annual, 62–63, 17: 15533 (NP-12645)

INTERNATIONAL ATOMIC ENERGY AGENCY, VIENNA.
Lectures on topics in nuclear theory, 17: 17302
Radioactive isotope therapy, 17: 15800
Symposium on biological effects of radiation, 17: 15762 (STI/PUB/60)

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Crystal structure of $Eu_2(WO_4)_3$, 17: 16663 (UCRL-10344)

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Environmental radioactivity in Italy, 7–12/61, 17: 15615 (BIO/06/62)

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Magnetic polarization of nuclei, 17: 17121 (LNF-62/102)

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Apparatus for detecting coincidence between low-energy photons, 17: 16426 (ISS-62/26)
Free air ionization chamber. I., 17: 16423 (ISS-62/9)
Free air ionization chamber. II., 17: 16424 (ISS-62/10)
Negative pion absorption in complex nuclei, 17: 17108 (ISS-62/21)
Nuclear magnetic resonance with ultrasounds in Si, 17: 16779 (ISS-62/17)
Particle loss due to scattering in counter telescope, 17: 16422 (ISS-62/4)
Photoproduction from H of η^0 meson, 17: 16946 (ISS-62/15)
Photoproduction from H of particles of 279.2 Mev, 17: 16947 (ISS-62/24)
Photoproduction from H of particles of 300 Mev, 17: 17109 (ISS-62/27)
Photoproduction from H of particles of 400 Mev, 17: 17110 (ISS-62/28)
Photoproduction from H of particles of 500 Mev, 17: 17111 (ISS-62/29)
Photoproduction from H of particles of 600, 900, and 1000 Mev, 17: 17112 (IS-62/30)
Prog. rpt. of Sanita Subsection of INFN, 1961–62, 17: 16780 (ISS-62/23)
Program for calculating roots of n degree polynomial, 17: 16425 (ISS-62/11)

J

JOHNS HOPKINS UNIV., BALTIMORE.
Radiation effects on animal tissues, 17: 15631 (NP-12601)

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Angular distribution and polarization of recoil nuclei in capture of partially polarized μ^- mesons, 17: 17117 (JINR-P-1160)
Calculations of strongly deformed element properties using superfluid nuclear model, 17: 17113 (JINR-E-1154)
Cross section for compound-nucleus formation, 17: 17118 (JINR-P-1162)
Elastic p-p scattering at 8.35 Bev, 17: 16950 (JINR-P-1135)
Elastic π-π scattering at high energies, 17: 16951 (JINR-P-1150)
Elastic scattering of heavy ions, 17: 17115 (JINR-P-1153)
Equilibrium distribution of relativistic gas, 17: 16781 (JINR-P-1159)
Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
Forbidden meson configurations in multimeson decay, 17: 16952 (JINR-P-1161)
Radiative decays of resonance states, 17: 17119 (JINR-P-1164)
Regge poles and fire balls, 17: 16949 (JINR-E-1156)
Resonance model of N-N interactions, 17: 16948 (JINR-D-1128)
Secondary reactions of d and t capture, 17: 17116 (JINR-P-1157)
Strange particle production, 17: 16953 (JINR-P-1163)

K

KANSAS. UNIV., LAWRENCE.
Optical absorption of color centers in LiF containing Mg, 17: 15960 (TID-18146)

KERNFORSCHUNGSANLAGE, JÜLICH, GERMANY.
Sliding spark as light source for vacuum ultraviolet, 17: 16383 (JÜL-88-PP)
Transient phenomena connected with capacitor banks, 17: 16782 (JUL-99-PP)

KNOLLS ATOMIC POWER LAB., SCHENECTADY, N. Y.
BEAM I: beams on elastic foundations, 17: 16173 (KAPL-M-JVM-4)
Diffusion theory flux peaking at sharp corner, 17: 17092 (TID-16485)

L

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Determination of U in 20% TBP/kerosene, 17: 15883 (PG-Report-428)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. REACTOR GROUP, DOUNREAY, CAITHNESS, SCOTLAND.
Fission product detector using β discrimination, 17: 16430 (TRG-Report-464)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. REACTOR GROUP, SPRINGFIELDS, LANCS, ENGLAND.
Restrained bowing of fuel element, 17: 16661 (TRG-Report-441)

UNITED KINGDOM ATOMIC ENERGY AUTHORITY. RESEARCH GROUP. ATOMIC ENERGY RESEARCH ESTABLISHMENT, HARWELL, BERKS,

ENGLAND.
Calibration technique for determination of Rn-222, 17: 16417 (AERE-R-4165)
Cesium separation by AMP process. IV., 17: 16139 (AERE-R-4245)
Construction of variable temperature Gouy magnetic susceptibility apparatus, 17: 16380 (AERE-R-4186)
Generation of Te aerosols and filtration, 17: 15939 (AERE-M-1130)
Tables for correction of x-ray line breadths and peak height, 17: 15873 (AERE-R-4218)
Vacuum fusion apparatus for determination of O in UC and PuC, 17: 15872 (AERE-R-4216)
UNITED NUCLEAR CORP. DEVELOPMENT DIV., WHITE PLAINS, N. Y.
Prog. rpt. on continuous meter for O in Na, 9-12-62, 17: 15889 (UNC-5050)
UNITED STATES–EURATOM JOINT RESEARCH AND DEVELOPMENT PROGRAM.
EURATOM Quarterly Digest, Vol. 2, No. 3, 17: 17441
Fission-product migration in and release from Fe–20 wt. % Cr, 17: 16638 (BMI-1611)
Prog. rpt. on application of steam–H_2O spray to reactor cooling, 10–12/62, 17: 17406 (EURAEC-519)
Prog. rpt. on application of steam–H_2O spray to reactor cooling, 10–12/62, 17: 17407 (EURAEC-537)
Prog. rpt. on burnable poison additions to UO_2, 12/62, 17: 16605 (CEND-173)
Prog. rpt. on corrosion problems, 1–3/60, 17: 16594 (EURAEC-29)
Prog. rpt. on critical boiling water burnout, 10–12/62, 17: 16237 (EURAEC-523)
Prog. rpt. on diffusion of rare gases in solids, 12/11/61–10/12/62, 17: 16665 (EURAEC-363)
Prog. rpt. on ductile-brittle transition temperature, 10-12/62, 17: 16644 (EURAEC-561)
Prog. rpt. on fabrication of pressure vessels, 10-12/62, 17: 16611 (EURAEC-551)
Prog. rpt. on fission gas release from UO_2, 10-12/62, 17: 16645 (EURAEC-568)
Prog. rpt. on Garigliano reactor, 9–12/62, 17: 17539 (GEAP-4164)
Prog. rpt. on hot channel and hot spot calculation, 10–12/62, 17: 17408 (EURAEC-584)
Prog. rpt. on imperfections in metals, 10–12/62. II., 17: 16583 (EURAEC-545)
Prog. rpt. on improved Zr alloys, 10–12/62, 17: 16582 (ARF-B198-36)
Prog. rpt. on in-pile corrosion of nuclear materials, 10–12/62, 17: 16584 (EURAEC-550)
Prog. rpt. on metal oxidation and corrosion resistance, 10–12/62, 17: 16596 (EURAEC-559)
Prog. rpt. on physical properties of UO_2 single crystals, 10-12/62, 17: 16642 (EURAEC-524)
Prog. rpt. on preparation and irradiation of U–UC cermets, 3–6/61, 17: 16528 (EURAEC-126)
Prog. rpt. on production of Zr alloy powders, final, 12/16/61–7/15/62, 17: 16529 (EURAEC-509)
Prog. rpt. on Pu recycle, 7-9/62, 17: 16738 (GEAP-4081)
Prog. rpt. on spent fuel shipping, 1–3/62, 17: 16313 (EURAEC-292)
Prog. rpt. on steel corrosion in high-temperature H_2O and steam, 10–12/63, 17: 16595 (EURAEC-552)
Prog. rpt. on swaged UO_2 fuel elements, final, 4/60-6/61, 17: 16610 (EURAEC-522)
Prog. rpt. on swelling of U, 10-12/62, 17: 16643 (EURAEC-548)
Prog. rpt. on U interstitial phases, 12/62, 17: 16522 (NCSC-2663-10)
Prog. rpt. on water and radioactive residues, 10–12/62, 17: 17620 (EURAEC-518)
UTAH. UNIV., SALT LAKE CITY.
Prog. rpt. on liquid coolants, 1/28/61–1/31/62, 17: 16031 (TID-17275)

V

VANDERBILT UNIV., NASHVILLE.
Effects of irradiated dog food, 17: 16368 (NP-12606)
VIRGINIA. AGRICULTURAL EXPERIMENT STATION, BLACKSBURG.
Prog. rpt. on effects of irradiated diet, 9/15/62, 17: 16363 (NP-12600)

W

WAKE FOREST COLL., WINSTON-SALEM, N. C.
Prog. rpt. on effects of irradiated diet, 3/15–9/15/62, 17: 16361 (NP-12598)
WEATHER BUREAU, OAK RIDGE, TENN.
Meteorological data for Oak Ridge, 17: 16264 (ORO-199)
WESTINGHOUSE ELECTRIC CORP. ATOMIC POWER DEPT., PITTSBURGH.
Organic moderated fluidized bed reactor experiment, 17: 17428 (WCAP-1635)
WESTINGHOUSE ELECTRIC CORP. ATOMIC POWER DIV., PITTSBURGH.
Effects of irradiation on pressure tube material, 17: 16734 (CVNA-159)
WESTINGHOUSE ELECTRIC CORP. BETTIS ATOMIC POWER LAB., PITTSBURGH.
Boiling water at high pressure, 17: 16235 (WAPD-T-1566)
Isotopic content of irradiated UO_2 fuel rods, 17: 17574 (WAPD-T-1461)
Reactor coolant radionuclide base levels. PWR Core 1, Seed 3, 17: 17573 (WAPD-PWR-TE-128(Rev.))
Tritium concentration in PWR using Li-7 resin, 17: 17572 (WAPD-PWR-TE-103)
WESTINGHOUSE ELECTRIC CORP. RESEARCH LABS., PITTSBURGH.
Prog. rpt. on vacuum techniques, annual, 1962, 17: 16181 (TID-18283)
WISCONSIN. UNIV., MADISON.
Polarization from reactions, 17: 17125 (TID-18137)
Scattering of polarized neutrons, 17: 17094 (TID-18277)
WORTHINGTON CORP. ADVANCED PRODUCTS DIV., NEWARK, N. J.
Prog. rpt. on high-pressure pump seal, 12/62–2/63, 17: 16183 (NYO-9801)

Y

YALE UNIV., NEW HAVEN.
Prog. rpt. on nuclear physics, 2/63, 17: 17123 (TID-18127)

PERSONAL AUTHOR INDEX

Each entry after an author's name is a shortened version of the title of the report or article, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt." This change permits a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

Because of problems involving the mechanical preparation of this index, all accent marks are omitted. The following changes in spelling have been introduced to reduce some of the confusion which might result from omitting the accents:

æ	**becomes**	**ae**
ö		**oe**
ø		**oe**
ü		**ue (except in transliterated Chinese names)**

A

AAGAARD, Per, Fission of rare earth elements, 17: 16052 (TID-18261 (p.44-8))

AAMODT, Richard E., Model of electrical discharge in neutral gas, 17: 17364

ABAGYAN, L. P., Construction of multigroup resonance constants, 17: 17470

ABDEL-WAHAB, M. F., Changes in ascorbic acid content of seeds of *Vicia faba* induced by β radiation, 17: 15716

ABE, Ken, Photoprotons from S-32, 17: 17155

ABELES, F., Optical properties of Au–Ni alloys, 17: 16696

ABERCROMBIE, S. D., Ground-based detection of atomic weapons, 17: 16901

ABRAHAMSON, E. W., Apparatus for study of primary processes in radiation chemistry, 17: 16044 (TID-18144)

ABRAMOFF, Peter, Prog. rpt. on radiation effects on antibody response, final, 10/61–9/62, 17: 15639 (TID-18194)

ABRAMS, I. J., Distant geomagnetic field. III., 17: 16280

ABRAMSON, R., Dilatometric study of Pu, 17: 16562

ACCARY, Andre, Making UC articles, 17: 16619

ACHENER, P. Y., Prog. rpt. on Rb/Cs evaluation, 10–12/62, 17: 16768 (AGN-8075)

ACKLEY, R. D., Control of accident-released fission products, 17: 16327 (ORNL-3401(p.43-55))

ADAMS, D. E., Transient natural convection on flat vertical surfaces, 17: 16246

ADAMS, J. F., Analysis for HNO_3 and $(NO_3)^-$ in $UO_2(NO_3)_2$ and $Pu(NO_3)_4$, 17: 15875 (HW-76363)

ADAMSKI, T., Radiation damage effects in Ba chromate crystals, 17: 16753

ADDISON, C. C., Anhydrous nitrates of Group II metals, 17: 15995

ADLER, K. L., Two-zone core temperature for PNPF, 17: 17544 (NAA-SR-Memo-7952)

ADLER, Yu. P., Model for extraction of Hf and Zr with TBP, 17: 16165

ADLER, Yu. P., Optimum conditions in extraction of Hf with TBP, 17: 16166

ADLOFF, Jean-Pierre, Effect of γ radiation on diphenyl Hg, 17: 16062

ADOLPHE, M., Oils, lipoxidase, and radiations, 17: 15813

AEBERSOLD, P. C., Low-dose radiation processing of food, 17: 15558

AGAMIROV, S. Sh., Precipitation of U in Black Sea, 17: 16276

AGRON, P. A., Xenon tetrafluoride molecule and its thermal motion, 17: 16023

AHMAVAARA, Y., Relativistic quantum theory. IV., 17: 16960

AHRENS, L. H., Neutron numbers 98, 108, and 116, 17: 17157

AKABOSHI, Mitsuhiko, Chemical protection of lymphatic cells against γ irradiation, 17: 15833

AKASOFU, Syun-Ichi, Dynamical morphology of the Aurora Polaris, 17: 16293

AKATSU, Johkun, Separation of U, Pu, and fission products by multistage extraction, 17: 16158

AKISHIN, A. I., Sputtering of mica and quartz by Kr ions, 17: 16817

ALBERS, H., Irradiation of test pieces in Würenlingen, 17: 16754

ALBERT, F. G., Radiation analysis, 17: 16487

ALBERTI, W., Irradiation cubicle, 17: 16345

ALCOCK, Norman Z., Measuring mass per unit area of coating, 17: 16399

ALCOCK, Norman Z., Measuring mass per unit area of subject material, 17: 16400

ALDER, F., Dose from single intake of radioactive material, 17: 15628 (EIR-41)

ALDRIDGE, W. G., Catabolism of nucleic acids. V., 17: 15685

ALEXANDER, P., Hypothesis for radiosensitization by O, 17: 15795

ALEXANDER, Peter, Increased RNAse activity in lymphatic cells following irradiation, 17: 15690

ALEXANDER, S., Knight shifts in Nb–Mo alloys, 17: 16709

ALEXEFF, I., Optimum energy for plasma confinement, 17: 17365

ALFVEN, Hannes, Matter-antimatter annihilation and cosmology, 17: 16911

ALFVEN, Hannes Olof Goesta, Generation of extremely high temperature, 17: 17391

ALGER, Raymond S., [Effects of radiation on] dielectric fluids, 17: 16106

ALI, Saqeba S., Density distribution of He-6, 17: 17176

ALIDIERES, M., Behavior of plasma produced by button-type source, 17: 17360

ALIMARIN, I. P., Determination of Nb by means of lumogallion, 17: 15929

ALIRE, Richard Marvin, Spectroscopic study of rare earth complexes, 17: 16025

ALKEMADE, C. Th. J., Fluctuations in counting rate of photomultipliers, 17: 16456

AL-KITAL, Rahim Abid, Mechanism of $C^{13}(n,\alpha)Be^9$ reaction at 14 Mev, 17: 17288

ALLEN, Anneke S., Apparatus for production of U, 17: 16134

ALLEN, Donald R., Apparatus for production of U, 17: 16134

ALLEN, Leland C., Binding of Xe to halogens, alkali metals, and itself, 17: 16007

ALLEN, P., π^+ Decay of He hypernucleus, 17: 17190

AL'PERT, Ya. L., Effects induced by fast-moving artificial satellite in ionosphere, 17: 16863

ALSAGER, Melvin, Survey of dental x-ray machines in Idaho, 17: 16340

ALSTON, Margaret H., 1660-Mev Y_1^* hyperon, 17: 17041

ALTMAN, K. I., Catabolism of nucleic acids in rat. IV., 17: 15684

ALTMAN, K. I., Catabolism of nucleic acids. V., 17: 15685

ALVAREZ, Luis W., 1660-Mev Y_1^* hyperon, 17: 17041

AMAVIS, Rene, Ion exchanger, 17: 16030
AMELL, Alexander R., Prog. rpt. on radiation effects on chemical systems, annual, 1962, 17: 16043 (TID-18094)
AMIRAGOVA, M. I., Influence of peroxides on radiochemical transformations of purines, 17: 15779
AMIS, E. S., Kinetics of the reduction of Np(V) with iodide ion, 17: 16003
AMMAR, R. G., Lifetime of the He hypernuclei, 17: 17202
AMOSOV, V. M., Electrolytic production of Ta and Nb and their alloys, 17: 16547
ANAND, S. P. S., Virial theorem for plasmas, 17: 17372
ANDERSEN, A. J., Uptake of radiostrontium from Danish soils, 17: 15613
ANDERSEN, E., NORA—zero-power experimental reactor facility, 17: 17595 (KR-41)
ANDERSON, E. W., Kinetic study of $H_2POOH-D_2O$ exchange, 17: 15988
ANDERSON, J. D., Direct (p,n) reaction in medium A nuclei, 17: 17226
ANDERSON, J. K., Transients following He line failure at PRTR pressurizer, 17: 17540 (HW-75731)
ANDERSON, L. L., Effect of nuclear explosion on radio propagation, 17: 15536
ANDERSON, P. W., Plasmons, gauge invariance, and mass, 17: 17375
ANDREEV, S. I., Radiation spectra of pulse discharge, 17: 16393
ANDREEV, Vladimir Ch., Skin reactions after irradiation—radiobiotropism, 17: 15757
ANDREWS, Giles J., Radioisotope scanning for pericardial effusions, 17: 15582
ANGELBECK, Albert W., Oscillating-electron plasma source, 17: 17323 (ARL-62-471)
ANGHILERI, Leopoldo J., Stability of I^{131}-labeled Na *o*-iodohippurate, 17: 15699
ANGRIST, S. W., Nernst effect power generator, 17: 16187
ANGUENOT, Francois, Ants as indicators for fallout, 17: 15620
ANIKINA, L. I., Crystal structure of umohoite, 17: 15984
ANISOVICH, V., V., Angular distribution of three particles produced near threshold, 17: 17098
ANSELIN, F., Examination of Pu metal by x-ray diffraction, 17: 16560
ANSELM, A. A., Weak coupling motion of Regge poles, 17: 17277
APARICIO ARROYO, E., Superficial activities of powders with BET apparatus, 17: 16606 (JEN-81-DMe/16)
APPEL, H., Scattering of neutrons by U from 18 to 120 Mev, 17: 17159
ARATA, Yoshiaki, Plasma arc torch, 17: 16220
ARAUJO, J. M., Vibrations of spherical nuclei, 17: 17285
ARBER, V., Effect of radiation on phage *lambda*, 17: 15790
ARBUSOW, S. J., Pecularities of radiation injuries and protection of intact and sympathectomized animals, 17: 15844
ARD, W. B., Plasma physics, 17: 17332 (ORNL-3392(p.28-46))
ARDEN, Thomas Victor, Treatment of water contaminated by radioactive substances, 17: 15867
ARMOUR, S. F., Design of MWe boiling water—separate superheat reactor, 17: 17536 (GEAP-4057)
ARMSTRONG, Arthur A., Jr., Prog. rpt. on radiation uses in textile industry, annual, 11/61–10/62, 17: 16041 (NCSC-2477-10)
ARMSTRONG, J. R., Prog. rpt. on brazing of refractory alloys, 11/62–1/63, 17: 16608 (NP-12615)
ARMSTRONG, R. J., Effects of high-altitude thermonuclear explosion, 7/62, 17: 16297
ARMSTRONG, W. M., Creep deformation of stoichiometric UO_2, 17: 16687
ARNETT, L. M., Hazards evaluation of HWCTR, 17: 17592 (DP-600)
ARNOLD, E. D., Radiochemical-plant safety, 17: 16329 (ORNL-3401 (p.63-72))
ARNOLD, Wayne R., Neutron generating apparatus, 17: 16415
ARNOLDY, Roger Lee, Outer Van Allen trapped radiation, 17: 16937
ARONSTEIN, R. E., Uranium–Mo alloy fuel costs, 17: 16521 (NAA-SR-Memo-2974)
Arroyo, E., Aparicio
see Aparicio Arroyo, E.
ARTHUR, M. G., Criticality measurements on Pu metal, 17: 16941 (RFP-63)
ARYA, Atam P., Directional correlations (γ-γ) in Rh-105, 17: 17169
ASCARELLI, G., Nuclear magnetic resonance with ultrasounds in Si, 17: 16779 (ISS-62/17)
ASCOLI-BARTOLI, U., Schlieren photography of an orthogonal pinch, 17: 17355
ASPREY, L. B., Compounds of divalent lanthanides, 17: 15950 (LADC-5566)
ASWATHANARAYANA, U., Geochemical studies in U prospect. I., 17: 16303
ATEN, A. H. W., Jr., Coprecipitation of actinides, 17: 16079
AUCHAMPAUGH, G. F., Fission cross section of U-235, 17: 17129 (UCRL-6926)
AUCHAMPAUGH, G. F., Photoneutron cross sections of Ta-181 and Ho-165, 17: 17227
AUERBACH, Robert, Thymus: its role in lymphoid recovery after irradiation, 17: 15752
AUGENSTEIN, L. G., Enzyme inactivation by radiation, 17: 15783
AUGENSTEIN, L. G., Physical mechanisms in enzyme inactivation, 17: 15780
AUSLAENDER, J. S., Angular distributions of muons in π^- μ decay at rest, 17: 17019
AUSTERN, N., Direct reactions, 17: 17303
AUSTIN, A. L., Transient stress distribution in rapidly heated rod, 17: 16260 (HE-150-210)
AVRAMITO, Maurice, Improvements in fuel elements, 17: 17484
AYMAR, R., Behavior of plasma produced by button-type source, 17: 17360
AYRE, James Lewis, Improvements in fluid flow indicators, 17: 16254
AZIMOV, Yu. I., Weak coupling motion of Regge poles, 17: 17277
AZUMA, T., Fractionation in fallout particles, 17: 16344

B

BABA, Hiroshi, Fission of light elements, 17: 16053 (TID-18261(p.49-60))
BABAYAN, Kh. P., Ionization bursts and spectrum of nuclear-active particles at mountain heights, 17: 16934
BABENKO, N. P., Neutron polarization in $C^{13}(d,n)N^{13}$ reaction, 17: 17264
BABICKY, Arnost, Calcium metabolism in epi- and metaphysis after local x irradiation. V., 17: 15755
BABIKOV, V. V., Resonance model of N-N interactions, 17: 16948 (JINR-D-1128)
BABKO, A. K., Absorption spectra of Zr complexes and ionic forms of reagents, 17: 15927
BACHELET, F., Spectral variation of primary cosmic rays during Forbush decreases, 17: 16930
BACKENSTOSS, G., Scattering of 8-Bev μ mesons on electrons, 17: 17017
BADALOV, N. B., Positron decay of Re-182, 17: 17259
BADELLINO, F., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
BAGGE, E., First German ship with nuclear propulsion, 17: 17579
BAHCALL, John N., Overlap and exchange effects in β decay, 17: 17221
BAILEY, Donald W., Histoincompatibility and X chromosome in mice, 17: 15585
BAILY, Norman A., Dosimetry of space radiations, 17: 16452
BAIN, A. S., Irradiation of Zy-2 clad UO_2, 17: 16735 (EXP-NRX-2807)
BAKER, P. S., Extraction recovery of irradiated U, 17: 16145 (ORNL-3312)
BAKER, R. C., Glove box design for Pu reclamation facility, 17: 16141 (HW-68442)
BAKER, Richard S., Electromagnetic pumps for Na service, 17: 16176 (NAA-SR-Memo-7955)
BAKKE, J. C., Instrumentation for space radiation. II., 17: 16893
BAKOV, A. T., Gamma spectra in capture of thermal and fast neutrons, 17: 17255
BALASHOV, Yu. A., Regularities of TR distribution in crust of earth, 17: 16277
BALATA, P., Spectral variation of primary cosmic rays during Forbush decreases, 17: 16930
BALAZS, Louis A. P., Pion resonance, Regge poles, and Chew-Frautschi saturation principle, 17: 17037
BALDWIN, George C., Neutron detector, 17: 16484
BALIAN, R., Formalism for many-body problem at nonzero temperature. II., 17: 17071
BALIAN, R., Level density for nucleons in a p-shell, 17: 17070
BALIAN, R., Singularities of *s*-matrix after canonical transformation, 17: 16978
BALL, Samuel Graham, Curing of polymeric compositions, 17: 16114
BALZARINI, D., Cherenkov and scintillation properties of Plexiglas UVT and UVA, 17: 16418 (BNL-6865)

BAME, S. J., Neutron flux and energy spectrum above atmosphere, 17: 16922
BANERJI, Samir K., Uranium(VI)–chromotropic acid chelate, 17: 16073
BANFI, Denes, Preparation of phthaloylglycine-1-C^{14}, 17: 16035
BANNING, R. O., Prog. rpt. on brazing of refractory alloys, 11/62–1/63, 17: 16608 (NP-12615)
BARAKAT, M. Z., Changes in ascorbic acid content of seeds of *Vicia faba* induced by β radiation, 17: 15716
BARANGER, M., Calculation of line widths, 17: 17324 (GAMD-927)
BARANY, J., Quantum chemical explanation of radiation effect, 17: 15708
BARASHENKOV, V. S., Strange particle production, 17: 16953 (JINR-P-1163)
BARBOUR, Benjamin H., Angiotensin labeled with I-131 and with H-3, 17: 15597
BARDAKCI, K., N/D method for complex partial waves, 17: 16850
BAREISS, Erwin H., Results from Fricke diffusion kinetics code, 17: 16502 (ANL-6560)
BARGER, J. W., Thermionic emission of actinide compounds, 17: 16783 (LADC-5128)
BARIKOV, V. G., Amperometric determination of U, 17: 15922
BARKAS, Walter H., Muon scattering in Fe, 17: 17228
BARKOVA, A. M., Determination of absorbed x-ray doses in animals, 17: 16350
BARNES, D. E., External hazard from equipment generating x rays, 17: 16335
BARNES, W. S., Atomic collisions in space phenomena, 17: 16886
BARO, G. B., Rhenium isotope (2.8 hr.), 17: 17242
BAROCH, C. J., Evaluation of Zr–Nb cladding for BWR, 17: 16586 (GEAP-4098)
BARON, Norton, Cross section of deuteron-induced reactions, 17: 17216
BARONCELLI, F., Extraction of Pu(IV) nitrate with tertiary amine nitrates, 17: 16154
BARONCELLI, F., Extraction of U(VI) from HNO_3 solutions, 17: 16155
BARONE, F. J., Fracture toughness of stainless steels, 17: 16640 (DMIC-Memo-164)
BARONETZKY, Egon O. M., Manufacture of Th-containing getters, 17: 16620
BARRE, J. J., Radioactive energy sources for spacecraft propulsion, 17: 17611
BARRER, Lester A., Validity of radiation protection standards, 17: 16342
BARRETT, M. F., Extraction of lanthanons with alkali metal amalgams. I., 17: 16157
BARRETT, M. J., Gamma heating core structure metallic components, EGCR, 17: 17547 (TID-18095)
BARRETT, M. J., Neutron streaming from EGCR core, 17: 17548 (TID-18096)
BARRETT, M. J., Shielding analysis of service machine, EGCR, 17: 17549 (TID-18097)
BARSCHALL, H. H., Scattering of polarized neutrons, 17: 17094 (TID-18277)
BARSHAY, S., Spins and parities of excited baryons, 17: 17002
BARSKI, Georges, Radiosensitivity of tumor predecessor, 17: 15671
BARTHOLOMEW, Charles Yale, Jr., Penetration of Kr ions into Si, 17: 16870
BARTON, C. J., Fission product transport evaluations, 17: 16326 (ORNL-3401(p.39-43))
BARTTER, Frederic C., Angiotensin labeled with I-131 and with H-3, 17: 15597
BARUT, A. O., Crossing symmetry in S-matrix theory, 17: 17034
BARUT, Asim O., Invariant scattering amplitudes for arbitrary spins, 17: 17035
BASARGIN, N. N., Determination of Th in presence of rare earths, 17: 15926
BASIL, Helen, Rules for safety from contamination, 17: 16333 (AEC-tr-5690)
BASS, R., Coincidence study of $K^{38}(n,py)Ar^{38}$, 17: 17196
BASS, R. F., Photon-induced defects in Ge, 17: 16748
BASSI, P., Influence of RNA on leukocyte level in irradiated rat, 17: 15692
BASTARD, Claude, Forbidden collisions in π^--proton elastic scattering, 17: 16969
BASTIDE, R. P., Hydrogen ion beam from duoplasmatron source, 17: 16833
BASTIEN, Pierre L., K^--p interactions near 760 Mev/c, 17: 17042
BASU, Diptendu, Electron distribution function of plasma, 17: 17347
BATES, Charles C., Inspection for underground nuclear tests, 17: 16906
BATTLE, Norman, Improvements in fluid nuclear reactors, 17: 17479
BATTLE, Norman, Improvements in nuclear reactors, 17: 17494
BAUER, Arthur A., Fission-product migration in and release from Fe–20 wt % Cr, 17: 16638 (BMI-1611)
BAUER, Stefan George, Improvements in fluid nuclear reactors, 17: 17479
BAUER, Stefan George, Improvements in nuclear reactors, 17: 17494
BAUMANN, Norman P., Resonance integrals and self-shielding factors for detector foils, 17: 17106 (DP-817)
BAUMBACH, H. L., Preparation and micrometallurgy of Pu metal, 17: 16553
BAUMHOVER, A. H., Progress of fruit-fly control by irradiation, 17: 15560
BAUMILLER, Robert C., Effects of x-ray induced mutants in *Drosophila melanogaster*. I., 17: 15681
BAY, Z., Search for slow component in α ionization, 17: 16849
BEAVER, W. W., Prog. rpt. on high-temperature intermetallic compounds, annual, 1961, 17: 16637 (BBC-115)
BECAREVIC, A., Effects of x irradiation on RNA metabolism in rat liver, 17: 15798
BECAREVIC, A., Liver DNA injected into lethally-irradiated rats. I., 17: 15797
BECK, Paul A., Electron specific heat of transition elements, 17: 16698
BECKER, E. R., Effect of cortisone and x irradiation on *Trypanosoma lewisi* infection, 17: 15573
BECKER, Gerhard, Production of strong molecular beams in high vacua, 17: 16796 (AEC-tr-5695)
BECKER, K., Source of error in neutron personnel dosimetry with nuclear track emulsion, 17: 16434
BECKER, Kurt M., Burnout conditions for water in rod clusters, 17: 16238
BECKER, M. C., Plasma physics, 17: 17332 (ORNL-3392(p.28-46))
BEDER, D., Reorientation effects in heavy-ion Coulomb excitation, 17: 17140
BEELER, J. R., Jr., Computer programs describing collision cascades in binary materials. I., 17: 16778 (GEMP-192)
BEGLIOMINI, A., Determination of isodose curve in a Co-60 source, 17: 15578
BEGZHANOV, R. B., Lifetime of 0.845-Mev level in Fe-56, 17: 17265
BEIERWALTES, William H., Hematologic changes following I-131 therapy, 17: 15696
BEIRNE, T., Electron bombardment furnace for general laboratory use, 17: 16191
BELL, Francis Robert, Improvements relating to reactor core, 17: 17488
BELL, Francis Robert, Nuclear reactor core, 17: 17489
BELL, Francis Robert, Nuclear reactor core, 17: 17522
BELL, George I., Neutron probability distribution in multiplying assembly, 17: 17091 (LADC-5383)
BELL, J. S., Formal theory of the optical model, 17: 17067
BELL, J. S., Functional integrals in statistical mechanics, 17: 17066
BELL, P. R., DCX-2, 17: 17331 (ORNL-3392(p.11-27))
BELLETTINI, G., Measuring the η^0 lifetime, 17: 17184
BELLI, M. L., Modification of beta-indolacetic acid by radiations, 17: 15776
BELLION, B., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
BELOV, S. P., Gamma spectra in capture of thermal and fast neutrons, 17: 17255
BEL'SKAYA, Zh. N., Spherical harmonics in transport theory. P_3 approximation, 17: 17457
BELYAEV, B. N., Regularities in α decay of nuclei with less than 126 neutrons, 17: 17256
BELYAEV, S. T., Collective properties of nuclei, 17: 17308
BELYAEVA, E. M., Changes in proteins in early states of radiation sickness, 17: 15770
BEMPORAD, C., Measuring the η^0 lifetime, 17: 17184
BENES, L., DNA synthesis after irradiation, 17: 15782
BENNEMANN, K. H., Lattice point defect configurations, 17: 15956 (TID-16340)
BENNEWITZ, H. G., Molecular beam detector, 17: 16466
BENVENISTE, J., Level structure of Ni-64 and Zn-64, 17: 17239
BERENDT, G., Regge poles for hard-core potential scattering, 17: 16992

BERENGARD, A. S., Chlorination of loparite concentrate, 17: 16024
BEREZIN, F. N., Small-size pulse-height analyzer, 17: 16465
BEREZINA, N. M., Radiation effects on morphological changes in plants, 17: 15749
BERG, William G., Gamma ray caliper, 17: 16411
BERGAN, R. A., Instrumentation for lunar surface analysis, 17: 16894
BERGE, J. Peter, K^--p interactions near 760 Mev/c, 17: 17042
BERGGREN, K. F., Hyperfine interaction in Li, 17: 16846
BERKELMAN, K., Search for photoproduction of η^0 meson, 17: 16987
BERKOWITZ-MATTUCK, Joan B., Mass-spectrometric study of vaporization of Li and Na metaborate, 17: 15944 (AROD-006.7)
BERMUDEZ POLONIO, J., Reaction of uranyl hydroxide with carbonic acid intermediate step in obtaining uranyl carbonate, 17: 15969
BERNSTEIN, I. A., Mitotic inhibition in rat skin resulting from β radiation, 17: 15694
BERTANZA, L., Spin of the Y_1^*, 17: 17039
BERTHOD, Louis, Nuclear reactors, 17: 17520
BERTOTTI, B., Equilibrium in ionized gases, 17: 16827
BESCO, D. G., Computer programs describing collision cascades in binary materials. I., 17: 16778 (GEMP-192)
BESSIS, D., One-particle exchange in antiproton collisions in flight, 17: 16984
BESSON, Jean, Reactions of CO_2 on U, 17: 15980
BETH, R. A., Magnet design suggestions, 17: 17310 (BNL-6844)
BETZ, F. W., Search for $\mu \rightarrow e + e + e$, 17: 17026
BEWLEY, D. K., Fractionated x-ray treatment of skin of pigs, 17: 15662
BHOWMIK, B., Binding energies of λ^0 hyperon in hypernuclei, 17: 17175
BIANCHI, G., Numerical analyses of "s" neutron resonances, 17: 17096
BIANCHI, M., Sensitization of blood red cells to x rays, 17: 15786
BIBICHEV, B. A., Neutron polarization in $C^{13}(d,n)N^{13}$ reaction, 17: 17264
BIEDENHARN, L. C., Derivation of asymptotic expansions of exponential integrals, 17: 17133
BIGG, E. K., Influence of moon on geomagnetic disturbances, 17: 16285
BIGHAM, C. B., Physics of D_2O lattices, 17: 17402 (AECL-1684)
BIGWOOD, E. J., Plasma levels after x-ray irradiation, 17: 15784
BILENKII, S. M., Determination of K^*-meson spin, 17: 17055
BINARD, L., Isomeric level of Sb-122, 17: 17151
BINGHAM, Harry, Existence and spin of f^0 resonance, 17: 16965
BIRKBECK, J. A., Radioiodine uptake studies in newborn infants, 17: 15600
BIRKENSHAW, Deric, Safety release mechanism for nuclear reactors, 17: 17515
BIRKS, La Verne S., Jr., System for recording parallel x rays, 17: 16486
BIRNBAUM, Howard K., Formation of point defects during plastic deformation, 17: 16657 (TID-16506)
BISHOP, W. N., Stopping cross sections of low-energy tritons, 17: 17212
BISIACCHI, G., Born approximation for electron and positron scattering, 17: 17186
BLACKMAN, L. C. F., Lattice defects and sintering of oxides, 17: 16534
BLAISDELL, Richard K., Ionizing radiation and human leukemia, 17: 15834
BLAKE, C. A., Jr., Solvent extraction with TBP, 17: 16146 (ORNL-TM-527)
BLAKE, Leslie Reginald, Metal oxide content of a liquid metal, 17: 16409
BLANC, Claude, Isotopic composition of K of different origins, 17: 16270
BLANC, Daniel, Isotopic composition of K of different origins, 17: 16270
BLANCHARD, Peter Michael, Radiation-resistant lubricants, 17: 15866
BLANCO, R. E., Prog. rpt. on waste disposal, 8–10/62, 17: 17619 (ORNL-TM-482)
BLANCO, R. E., Solvent extraction with TBP, 17: 16146 (ORNL-TM-527)
BLANDIN, A., Effects of size and chemical interactions, 17: 16694
BLEICHROTH, Wolfgang, System Fe–P–Nb, 17: 15971
BLIEDEN, H. R., Resonant behavior in (p,α) and (α,p) data, 17: 17188
BLINOVA, N. I., Magnetic properties of U_3O_8, 17: 16674
BLOCH, C., Formalism for many-body problem at nonzero temperatures, 17: 17063
BLOEMBERGEN, N., Stark splitting of nuclear spin levels in GaAs, 17: 17209
BLOK, J., Effects of radiation on isolated DNA, 17: 15792
BLOMBERG, Claes, Theory of thermal properties of metals, 17: 16806
BLOOM, Ben, Synthesis of fatty acids by rat liver slices in tritiated water, 17: 15595
BLOOM, Stewart D., Nanosecond experimentation with pulsed machines, 17: 17282
BLUMENTHAL, Warren B., Zirconium chemistry in industry, 17: 15989
BOCCACCI, M., Sensitization of blood red cells to x rays, 17: 15786
BOCHIROL, Louis, Ionization-type heat exchange process, 17: 16257
BODMER, A. R., Density distribution of He-6, 17: 17176
BOES, L., Delay apparatus, type II, 17: 16503 (BLG-134)
BOESCHE, H., Effects of screens on irradiation time, 17: 15676
BOGDANOWICZ, J., Interactions of protons with heavy nuclei, 17: 17161
BOGHEN, J., Prog. rpt. on preparation and irradiation of U–UC cermets, 3–6/61, 17: 16528 (EURAEC-126)
BOGUSH, A. A., Determination of electron form factor, 17: 17053
BOHR, H., Uptake of Ca and Sr in normal and rachitic rats, 17: 15591
BOLLIGER, J. R., Instrumentation and control of in-reactor test facility, 17: 17593 (HW-SA-2945)
BOLOGNA, I., Effects of irradiation on rat liver, 17: 15785
BOLSTERLI, M., Invariant functions in nonrelativistic theory, 17: 16844
BOLT, Robert O., [Effects of radiation on] coolants, 17: 16101
BOLT, Robert O., [Effects of radiation on] lubricants, 17: 16102
BOLT, Robert O., [Effects of radiation on] coatings and films, 17: 16105
BOLT, Robert O., [Effects of radiation on] fuels and fluid shield materials, 17: 16107
BOLT, Robert O., [Effects of radiation on] coal, wood, and explosives, 17: 16108
BOLT, Robert O., Potential benefits [of radiation effects], 17: 16109
BOLT, Robert O., Radiation effects on organic materials, 17: 16094
BOLT, Robert O., Radiation chemistry of pure compounds, 17: 16097
BONDA, Robert, Validity of radiation protection standards, 17: 16342
BONDAREVA, T. P., Anodic oxidation of Nb, 17: 16675
BONNELLE, Christiane, M absorption spectrum of Pu, 17: 16814
BONNET, Georges, Magnetic demagnetizing devices, 17: 16402
BONNET, Georges, Theory of metrology for earth's magnetic field, 17: 16263 (CEA-2035)
BONNET, John D., Determining radioactivity in feces, 17: 15894
BONTE, Frederick J., Radioisotope scanning for pericardial effusions, 17: 15582
BOOZ, Jochen, Formation of ion pairs in gases by radiation, 17: 16086
BOPP, C. Daniel, [Effects of radiation on] polymers, 17: 16098
BOPP, C. Daniel, [Effects of radiation on] plastics, 17: 16099
BORA, K. C., Radiation-induced free radicals and identification, 17: 15763
BORCHERS, R. R., Neutrons from proton bombardment of Li, 17: 17220
BORN, James L., Treatment of chronic lymphocytic leukemia, 17: 15697
BORN, John W., [Effects of radiation on] elastomeric materials, 17: 16100
BOROUGHS, H., Insect control in Latin America by radiation, 17: 15562
BOROUGHS, H., Wetting agents in foliar nutrition, 17: 15557
BORT, Charles Ian, Process for working Be, 17: 16618
BOSE, Sudesh, Properties of vertex functions in strong interactions, 17: 16954 (NP-12644)
BOUCHIAT, C., Violation of $|\Delta I| = \frac{1}{2}$ rule, 17: 16996
BOURGADE, P., Requirements for reactor model for teaching and research, 17: 17433
BOWEN, P. H., Scattering of neutrons by U from 18 to 120 Mev, 17: 17159
BOWERS, R., Magnetoplasma resonance in metals, 17: 16841
BOWLER, M., Tables for correction of x-ray line breadths and peak height, 17: 15873 (AERE-R-4218)
BOWMAN, C. D., Fission cross section of U-235, 17: 17129 (UCRL-6926)
BOYAZHAN, N. G., Ionization bursts and spectrum of nuclear-active particles at mountain heights, 17: 16934
BOZORTH, R. M., Magnetostriction and thermal expansion of Gd, 17: 16703
BOZZINI, A., Mutations in *durum* wheat induced by radiations, 17: 15731
BRACCINI, P. L., Measuring the η^0 lifetime, 17: 17184
BRADLEY, D. C., Quinquevalent compounds of U. III., 17: 15994
BRAMBLETT, R. L., Photoneutron cross sections of Ta-181 and Ho-165, 17: 17227
BRANDENBURG, M. K., Effects of γ radiation on pinyon pine, 17: 15733
BRANDSHTETR, I., Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
BRAUER, Earle W., Effects of depilatory x irradiation on hair growth in mice, 17: 15822
BRAY, A. P., HPD conceptual design study, 17: 17535 (GEAP-3967)
BREGADZE, I. F., Effects of chemicals on radiosensitivity of cells,

17: 15747
BREGER, Irving A., [Effects of radiation on] coal, wood, and explosives, 17: 16108
BRENENSON, Walter, Polarization of neutrons scattered by protons, 17: 17083
BRICE, David K., Direct spin-lattice relaxation processes, 17: 16839
BRIL, Kazimierz Jozef, Separating yttrium and rare earths, 17: 16168
BRINKMAN, H., Resonances in $P^{31}(p,\gamma)S^{32}$, 17: 17173
BRINKMAN, R., Irradiated red cell membrane, 17: 15787
BRISSON, V., Spin of the Y_1^*, 17: 17039
BRODE, Harold L., Weapons effects for protective design, 17: 16330 (P-1951(RAND))
BRODER, D. L., Inelastic neutron scattering on Fe, 17: 17473
BROECKER, Wallace, Delayed coincidence counter for actinon and thoron, 17: 16440
BROIDO, A., Gamma intensity in presence of shielding, 17: 17393 (NP-12611)
BRONISZ, S. E., Mechanical properties of alpha Pu in compression, 17: 16646 (LADC-5330)
BROOKS, N. B., Hydrogen ion beam from duoplasmatron source, 17: 16833
BROUDE, V. L., Spectrum of monodeuterobenzene, 17: 16010
BROUILLETTE, E. C., Skin friction for turbulent magnetofluidmechanic channel flow, 17: 16229 (NP-12631)
BROUT, R., Zero-temperature properties of many-fermion system, 17: 17031
BROWN, P. E., Reactor coolant radionuclide base levels. PWR Core 1, Seed 3, 17: 17573 (WAPD-PWR-TE-128(Rev.))
BROWN, R. J., High purity BeO for electronics, 17: 16612
BROWN, R. L., Magnetics and superconductivity, 17: 17336 (ORNL-3392 (p.66-85))
BROWN, W. Richard, Thermal expansion of UP_2O_7, 17: 16680
BROWNELL, W. E., Reactions between alkaline-earth sulfates and cristobalite, 17: 15986
BROWNING, W. E., Jr., Control of accident-released fission products, 17: 16327 (ORNL-3401(p.43-55))
BROWNING, W. E., Jr., Release of fission products on in-pile melting of fuels, 17: 16324 (ORNL-3401(p.27-35))
BRUMLEY, F. B., Neutron flux and energy spectrum above atmosphere, 17: 16922
BRUNELET, Lucien, Ionizing radiations. Calculations and tables, 17: 17080
BRUNSKILL, Robert Thompson, Improvements in monitors for α particles, 17: 16476
BRUNTON, Donald C., Measuring mass per unit area of subject material, 17: 16400
BRUSSAARD, P. J., Derivation of asymptotic expansions of exponential integrals, 17: 17133
BUCHDAHL, H. A., Heuristic approximations to equation of state, 17: 17343
BUCKHAM, J. A., Radioactive demonstration of pot calcination process, 17: 17616 (IDO-14596)
BUDD, Herbert F., Generalized path variable method, 17: 16511
BUECHLER, Alfred, Infrared spectra of alkali metaborate vapors, 17: 15945 (AROD-006.8)
BUECHLER, Alfred, Mass-spectrometric study of vaporization of Li and Na metaborate, 17: 15944 (AROD-006.7)
BUENRING, Wolfgang, Beta decay theory using electron radial wave functions, 17: 17177
BUEKI, Gergely, Characteristics of reactor cooling, 17: 17435
BUGL, Josef, Fission-product migration in and release from Fe–20 wt % Cr, 17: 16638 (BMI-1611)
BUKAT, G. M., Residual pair forces in O-18 and F-18, 17: 17275
BUKOVAC, M. J., Distribution of P-32, Ca-45, and Zn-65 in bean, 17: 15551
BULOS, Fatin Yusef, Photoproduction of neutral mesons from H, 17: 17082
BUNKA, H., Treatment of radiation injuries of bladder, 17: 15710
BURCH, Jack J., Magneto-telluric effects observed in Dallas, July 1962, 17: 15537
BURGESS, K. N., Creep-rupture behavior for type 316 stainless steel, 17: 16682
BURK, Maksymilian, Thermal conductivity of beryllia rod, 17: 16248
BURK, Maksymilian, Thermal conductivity of beryllia ceramics, 17: 16681
BURKHARDT, Howard L., Survey of dental x-ray machines in Idaho, 17: 16340
BURNS, Gerald, Spin Hamiltonian parameter D vs. axial crystal field for S-state ions, 17: 17210
BURNS, John H., Xenon tetrafluoride molecule and its thermal motion, 17: 16023
BURT, P., Solutions to Dirac equation with Yukawa potential, 17: 16990
BURT, W. R., Jr., Fabrication of fuel and blanket for AFSR, 17: 17591 (ANL-6107)
BUSSELMAN, G. J., Prog. rpt. on fuel re-use, 17: 17413 (HW-74549)
BYKOV, G. A., Effect of intracrystalline fields on γ quantum resonance absorption spectrum, 17: 17272

C

CAIANIELLO, E. R., Lectures on many-body problem, 17: 17060
CALBOREANU, A., Angular distribution of polarized neutrons from $Li^7(p,n)Be^7$, 17: 17167
CALDAROLA, L., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
CALDERINI, P., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
CALDWELL, J. T., Photoneutron cross sections of Ta-181 and Ho-165, 17: 17227
CAMPANILE, Vincent A., Polymerizing monomers using ionizing radiation, 17: 16122
CAMPBELL, I. D., Decay of irradiation defects in polymethyl methacrylate, 17: 16060
CAMPBELL, M. D., Iron pentacarbonyl–HF system and NMR of transition metal carbonyls, 17: 15962 (TID-18199)
CAMPBELL, M. D., Proton magnetic resonance of H_3O–HF system, 17: 15963 (TID-18200)
CAMPBELL, M. H., Analysis for HNO_3 and $(NO_3)^-$ in $UO_2(NO_3)_2$ and $Pu(NO_3)_4$, 17: 15875 (HW-76363)
CANNON, J. H., Irradiation and marrow infusion in leukemia, 17: 15546
CAPPADONA, C., Strontium-90: "hot zones" in skeleton, 17: 15606
CAPRINO, G., Ascorbic acid synthesis in rat-liver extracts, 17: 15656
CARLONI, Q. C., DYNAPAK extrusion of I & E fuel elements, 17: 16604 (BRB-69)
CARLSTON, C. E., Electron ejection from metals. I., 17: 16836
CARLSTON, C. E., Electron ejection from metals. II., 17: 16837
CARPENTER, D. L., Magnetospheric ionization density profile, 17: 16294
CARPENTER, F. D., Prog. rpt. on carbides for thermionic space reactors, 11/30/62, 17: 16516 (GA-3866)
CARRASCO GIMENO, F., Superficial activities of powders with BET apparatus, 17: 16606 (JEN-81-DMe/16)
CARRIGAN, Richard Alfred, Jr., Photoproduction of positive pions from H, 17: 17084
CARROLL, James G., [Effects of radiation on] coolants, 17: 16101
CARROLL, James G., [Effects of radiation on] lubricants, 17: 16102
CARROLL, James G., [Effects of radiation on] coatings and films, 17: 16105
CARROLL, James G., [Effects of radiation on] fuels and fluid shield materials, 17: 16107
CARROLL, James G., [Effects of radiation on] coal, wood, and explosives, 17: 16108
CARROLL, James G., Potential benefits [of radiation effects], 17: 16109
CARROLL, James G., Radiation effects on organic materials, 17: 16094
CARROLL, James G., Radiation chemistry of pure compounds, 17: 16097
CARSON, H. J., Fabrication of EBR-II Core I fuel elements, 17: 16602 (ANL-6276)
CARVER, J. G., Prog. rpt. on Pu recycle, 7–9/62, 17: 16738 (GEAP-4081)
CASHIN, W. M., Mixed-oxide concept for Pu power reactor, 17: 16576
Castro, Orlando Euler de
see Euler de Castro, Orlando
CATINO, Antonio, Autoradiographic determination of U, 17: 15895
CATINO, Antonio, Extraction of U from uraniferous minerals, 17: 16123
CATTERMOLE, J. M., Effects of tests in USGS Tunnel, NTS, 17: 15540
CAUCHOIS, Yvette, M absorption spectrum of Pu, 17: 16814
CAUQUAIS, Claude, Excited levels of Ir-188, 17: 17150
CAVALLI, A., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
CAVERLY, Myron R., Pilot plant for processing irradiated nuclear fuel,

17: 16140 (DP-757)
CEBELIEU, Rene, Improvements in fuel elements, 17: 17484
Cellini, R. Fernandez
see Fernandez Cellini, R.
CERRE, P., Treatment station for solid radioactive waste, 17: 17614 (CEA-2195)
CERVIGNI, T., Modification of beta-indolacetic acid by radiations, 17: 15776
CHAMBERLAIN, George E., Electron-proton charge difference and charge of neutron, 17: 17012
CHAMBERLAIN, J., Collapse in alpha U subjected to thermal cycles, 17: 16689
CHAMBERLAIN, O., Search for $\mu \rightarrow e + e + e$, 17: 17026
CHAMBERS, J. F., Effect of α radiation on protein monolayers, 17: 16061
CHAMOT, Cynthia, Results from Fricke diffusion kinetics code, 17: 16502 (ANL-6560)
CHANG, W. T., Utilization of x-ray radiation for rice, 17: 15564
CHAO, C. C., Binary alloys of rare earth metals with Au and Ag, 17: 16658 (TID-18197)
CHAPPELL, Samuel Estelle, Effect of radiation on polypropylene, 17: 16110
CHARLESWORTH, D. H., Attapulgus clay for organic coolant purification, 17: 15849 (CRCE-1131)
CHAUVIN, Remy, Ants as indicators for fallout, 17: 15620
CHECHERNIKOV, V. I., Magnetic properties of Sc, 17: 16723
CHEMLA, Marius, Controlling countercurrent electromigration apparatus, 17: 16496
CHEN, Tsung-mo, Photoproduction amplitude from dispersion relations, 17: 17274
CHENG, C. H., Electron specific heat of transition elements, 17: 16698
CHENG, F., EGCR temperature distributing moderator and reflector, 17: 17559 (TID-18238)
CHENG, F., Temperature distribution moderator and reflector core, EGCR, 17: 17550 (TID-18098)
CHERDYNTSEV, V. V., Primordial transuranium isotope in nature, 17: 16274
CHEREL, Guy, Remote-controlled manipulating apparatus for sealed chambers, 17: 16213
CHERKASOVA, L. S., Effect of radiation on protein metabolism, 17: 15781
CHERNIKOV, N. A., Equilibrium distribution of relativistic gas, 17: 16781 (JINR-P-1159)
CHERNOCK, W. P., Prog. rpt. on burnable poison additions to UO_2, 12/62, 17: 16605 (CEND-173)
CHERNOVA, N. A., Model for extraction of Hf and Zr with TBP, 17: 16165
CHERNYSH, A. P., Absolute age of paleolithic period by radiocarbon dating, 17: 16273
CHESTER, Peter F., Maser superconductive magnetic field producing means, 17: 16909
CHEYMOL, J., Oils, lipoxidase, and radiations, 17: 15813
CHIBISOV, M. I., Scattering of slow electrons on atoms, 17: 17269
CHICK, D. R., Transfer of Jason, 17: 17602
CHIDLEY, B. E., Ion exchange properties of Zr phosphate, 17: 15865
CHIOZZOTTO, M., Free air ionization chamber. I., 17: 16423 (ISS-62/9)
CHIOZZOTTO, M., Free air ionization chamber. II., 17: 16424 (ISS-62/10)
CHMIELEWSKI, Jerzy, One-channel amplitude analyzer, 17: 16392
CHO, Jong Soo, Infrared studies of $MgSO_4$ and ThO_2, 17: 16028
CHONE, B., Hematological viewpoints on supervoltage therapy, 17: 15820
CHOPE, Henry R., Radiation analysis, 17: 16487
CHOW, Kee-Tang, Process for irradiating pearls, 17: 16120
CHRISTENSON, C. W., Temperature rises in radioactive wastes, 17: 17617 (LADC-5366)
CHURCH, James S., Fabrication of custom gaskets, 17: 16175 (LAMS-2799)
CHWASZCZEWSKI, Stefan, Coaxial plasma gun, 17: 17354
CIBROWSKI, Stanislaw, Effect of γ irradiation on catalytic activity of Ni, 17: 16084
CIFALDI, S., Effects of splenectomy in animals subjected to irradiation, 17: 15811
CIFALDI, S., Spleen factor protective against radiation syndrome, 17: 15812
CIOK, P., Interactions of protons with heavy nuclei, 17: 17161
CLAMART, Petit, Nuclear reactor control, 17: 17589
CLANCEY, W. R., Design of MWe boiling water—separate superheat reactor, 17: 17536 (GEAP-4057)
CLARK, A. E., Reliable autoradiographic technique, 17: 15574
CLARK, John A., Prog. rpt. on low heat flux boiling, 10/61–1/62, 17: 16231 (TID-15719)
CLARK, W. E., Phosphite and hypophosphite to fix Ru from wastes, 17: 17618 (ORNL-TM-263)
CLARKE, William James, Radiation effects of bone-seeking radionuclides, 17: 15847
CLARKSON, Thomas B., Prog. rpt. on effects of irradiated diet, 3/15–9/15/62, 17: 16361 (NP-12598)
CLAUDE, George, Method of separating chemical bodies, 17: 16499
CLAUSING, R. E., Vacuum systems, techniques, and material studies, 17: 17337 (ORNL-3392(p.86-8))
CLAUSS, Francis J., Components in space environments, 17: 16724
CLAYER, Michel, Liquid moderator reactors, 17: 17499
CLAYTON, Colin G., Bulk photoconductivity detector for γ rays, 17: 16451
CLAYTON, H. H., Spherical harmonics method for thermal utilization in cylindrical cells, 17: 17089 (CRT-1088)
CLELAND, J. W., Photon-induced defects in Ge, 17: 16748
CLIFFORD, A. F., Iron pentacarbonyl–HF system and NMR of transition metal carbonyls, 17: 15962 (TID-18199)
CLIFFORD, A. F., Polarographic study of $Cu(Hg)_1$–$Cu(H_2O)^{++}$, 17: 15961 (TID-18198)
CLIFFORD, A. F., Proton magnetic resonance of H_2O–HF system, 17: 15963 (TID-18200)
CLOWES, F. A. L., Recovery of *Vicia faba* roots from radiation, 17: 15728
CLUBB, R. D., Radioactive luminous material hazard, 17: 16338
COBERLY, James C., Determination of I-131 in heterogeneous fecal specimens, 17: 15904
COBLE, R. L., Diffusion-controlled processes in Al_2O_3, 17: 16679
COCKS, George G., Fission-product migration in and release from Fe–20 wt % Cr, 17: 16638 (BMI-1611)
COESTER, F., Particles with zero and "small" mass, 17: 17022
COFFINBERRY, A. S., Metal Pu, 17: 16550
COFIELD, R. E., Inspection of Be chips by nonfilm radiation imaging, 17: 15890 (Y-1403)
COHEN, Bernard L., Cross section of deuteron-induced reactions, 17: 17216
COHEN, Bernard L., Energies of single-particle neutron states, 17: 17231
COHEN, J. A., Effects of radiation on isolated DNA, 17: 15792
COHEN, Lionel, Radiosensitivity of tumors and target theory, 17: 15664
COHEN, Morrel H., Spin-orbit coupling in band structure of Mg, 17: 16845
COHEN, Pierre, Ion exchanger, 17: 16030
COHEN-TANNOUDJI, C., Quantum theory of optical pumping cycle, 17: 17132
COLE, L. J., Hepatomas in fast-neutron-irradiated mice, 17: 15643 (USNRDL-TR-596)
COLE, L. J., Mouse fetal liver: source of immunologically reactive cells, 17: 15644 (USNRDL-TR-605)
COLE, L. J., Radiosensitivity of responses to skin grafts, 17: 15646 (USNRDL-TR-619)
COLLEY, Derek C., Double-charged pion production in (π^-,p), 17: 17028
COLLICA, C., Diagnosis of anemic states, 17: 15577
COLLINS, Zane L., Radio fluid detector, 17: 16482
COLLOPY, Thomas J., Inorganic surfactants in liquid-liquid extraction systems, 17: 16144 (NLCO-867)
COLLOT, Claude, Effect of cooling rate on γ-β transformation in U–Nb, 17: 16672
COLSTON, B. W., Four-group cross sections, 17: 17422 (NAA-SR-Memo-7789)
COLTON, R., Construction of variable temperature Gouy magnetic susceptibility apparatus, 17: 16380 (AERE-R-4186)
COLVIN, Gus W., Radiation injury to rectum and sigmoid colon, 17: 15807
COMPORTI, M., Ascorbic acid synthesis in rat-liver extracts, 17: 15656
CONNER, J. P., Neutron flux and energy spectrum above atmosphere, 17: 16922
CONNOLLY, P. L., Spin of the Y_1^*, 17: 17039
CONNOR, John C., Radiation detector, 17: 16481

CONNOR, R. D., Radiation fallout and its health implications, 17: 15619
CONRADS, H., Sliding spark as light source for vacuum ultraviolet, 17: 16383 (JÜL-88-PP)
COOK, J. R., Apochlorosis and photoreactivation in Euglena, 17: 15640 (TID-18203)
COOK, James C., Sarcoma-like tumors of skin following irradiation, 17: 15806
COOK, V., Elastic K⁺-proton scattering, 17: 17015
COOKE, D. J., Effect of nuclear explosion on radio propagation, 17: 15536
CORENZWIT, E., Knight shifts in Nb–Mo alloys, 17: 16709
CORGE, C. R., Numerical analyses of "s" neutron resonances, 17: 17096
CORNISH, J. J., Heat transfer in turbulent flow, I and II, 17: 16236 (AERE-Trans-911(Pts.1 & 2))
CORTELLESSA, G., Photoproduction from H of η^0 meson, 17: 16946 (ISS-62/15)
CORTINI, G., Fission of U, Th, and Bi by 20-Bev protons, 17: 17180
COULTER, J. R. M., Field reversal in tenuous plasma, 17: 16790 (TID-18216)
COULY, J. Pierre, Transistorized pulse amplifiers, 17: 16381 (CEA-1932)
COURTOIS, Guy, Ants as indicators for fallout, 17: 15620
COVEYOU, R. R., Expressions for 3-j symbols, 17: 16957 (ORNL-TM-514)
COWAN, F. P., Dosimetry for γ field irradiation facilities, 17: 15732
COWAN, Robert D., Measuring thermal diffusivity at high temperatures, 17: 16226 (LADC-5310)
COX, G. C., Scattering of neutrons by U from 18 to 120 Mev, 17: 17159
CRAIG, R. M., Polarization in proton–C scattering at 28 Mev, 17: 17198
CRAMER, E. M., Dilatometry and thermal analysis of Pu metal, 17: 16561
CRAMER, K. R., Magnetohydrodynamic free-convection solutions, 17: 16247
CRANSTON, F. P., Jr., Thermionic emission of actinide compounds, 17: 16783 (LADC-5128)
CRAVEN, J. D., Intensities of geomagnetically trapped particles, 17: 16924
CRAVITT, S., Prog. rpt. on stratospheric monitoring, 12/60–1/61, 17: 16319 (NYO-9674)
CRAWFORD, J. H., Jr., Photon-induced defects in Ge, 17: 16748
CREEK, G. E., Release of fission products on out-of-pile melting fuels, 17: 16323 (ORNL-3401(p.5-27))
CRITOPH, E., Physics of D_2O lattices, 17: 17402 (AECL-1684)
CROCKER, A. G., Orientation of dislocation loops in α U, 17: 16686
CROMBIE, D. D., Detection of high-altitude detonations, 17: 16900
CROMER, Don T., Crystal structure of Pu_3Co, 17: 16647 (LADC-5363)
CROOK, G. M., Observations of nuclear detonation, 7/62, 17: 16298
CROSS, Alan Clark, Electrical circuits for scintillation counting, 17: 16472
CULVAHOUSE, J. W., Direct spin-lattice relaxation processes, 17: 16839
CULVAHOUSE, J. W., Relaxation processes for divalent cobalt ions, 17: 16014
CULVER, J. S., DCX-2, 17: 17331 (ORNL-3392(p.11-27))
CUMMINS, J. T., Sodium dependence of bioelectric outputs in rat stomach, 17: 15645 (USNRDL-TR-608)
CUNNINGHAM, B. B., First isolation of Pu, 17: 16552
CUNNINGHAM, George W., Reactor materials from powders, 17: 17443
CURRAN, R. C., Reliable autoradiographic technique, 17: 15574
CURTIS, Howard J., Late effects of radiation, 17: 15726
CUTLER, Melvin, Prog. rpt. on high-temperature semiconductors, 10–12/61, 17: 16775 (GACD-2813)
CVELBAR, F., Radiative capture of 14-Mev neutrons in Al-27, 17: 17207

D

DAHL, O., K^- interactions in D: π^-pY final states, 17: 16981
DAHMEN, Guenter, Orthopedic aspects of late radiation injury, 17: 16339
DAKHNO, L. G., Angular distribution of three particles produced near threshold, 17: 17098
D'ALELIO, Gaetano F., Irradiated polymers, 17: 16115
D'ALELIO, Gaetano F., Irradiated polymers, 17: 16118
D'ALELIO, Gaetano F., Irradiated polymers, 17: 16119
D'ALELIO, Gaetano F., Irradiated polymers, 17: 16766
DALITZ, R. H., Strange particles and strong interactions, 17: 17079
DAMANI, V. D., Apparatus for fine-particle measurement, 17: 15937 (AEET/CD/4)
D'AMATO, F., Mutations in *durum* wheat induced by radiations, 17: 15731
DAMBURG, R. Ya., Resonances in scattering of electrons on H atoms, 17: 17270
D'ANGELO, N., Low-frequency oscillations in a K plasma, 17: 17362
DANIEL, E. V., Radiation spectra of pulse discharge, 17: 16393
DANIEL, H., Decay scheme for β transition Ag-110m → Cd-110, 17: 17251
DANYSZ, A., Effects of x radiation on toxicity of pharmaceuticals, 17: 15678
DA PROVIDENCIA, J., Perturbation theory in nuclear matter, 17: 17164
DARCIS, L., Vaginal and buccal responses to radiation, 17: 15666
DAS, M. Sankar, Determination of U by neutron activation analysis, 17: 15887 (TID-18204)
DA SILVA, J. J. R. F., Metal complexes of *N*-(2-pyridylmethyl)iminodiacetic acid, 17: 15993
DASTIDAR, Pranab Rebotiranjan, Improvements in monitoring equipment, 17: 17498
DAUTREPPE, D., Order-disorder transition in Fe–Ni, 17: 16701
DAVID, Lubomir, Coincidence method in measuring activity of β-γ sources, 17: 16439
DAVIDSON, M., Proton-deuteron interactions at 77 Mev, 17: 17009
DAVIS, Harold, Single dose x irradiation of lung and posterior mediastinum. III., 17: 15830
DAVIS, Jack W., Oscillating-electron plasma source, 17: 17323 (ARL-62-471)
DAVIS, M. E., Fission product transport evaluations, 17: 16326 (ORNL-3401(p.39-43))
DAVIS, Marshall E., Fission of Th and Rh induced by He ions, 17: 17124 (TID-18131)
DAVIS, Philip William, Improvements in plugs for pipes, 17: 16211
DAVIS, R. C., Ion production, acceleration, and injection, 17: 17334 (ORNL-3392(p.49-55))
DAVIS, W. C., Induction of homograft tolerance in mice, 17: 15760
DAVIS, W., Jr., Solvent extraction with TBP, 17: 16146 (ORNL-TM-527)
DAWSON, J. M., Use of magnetically compressed plasmas in stellarator, 17: 17326 (MATT-133)
DAWSON, John, Effect of ion correlations on plasma conductivity, 17: 17358
DAWSON, John, High-frequency conductivity of fully ionized plasma, 17: 17325 (MATT-130)
DAY, W. B., Prog. rpt. on electrodeless pulse plasma propulsion, final, 7/61–11/62, 17: 16771 (ASD-TDR-62-1105)
DAYTON, R. W., Reactor Materials, Vol. 6, No. 1, 17: 17442
DAYTON, Russell W., Prog. rpt. on civilian applications, 12/62, 17: 15532 (BMI-1607(Del.))
DEARNALEY, G., Radiation damage in Si detectors, 17: 16885
DEARNALEY, Jill, Interaction of Y with constituents of bone, 17: 15567
DE BERSUDER, Louis, M absorption spectrum of Pu, 17: 16814
DEBIESSE, Jean, Interpretation of energy conversion phenomenon, 17: 17346
DE BOER, J., Magnetic properties of deformed nuclei, 17: 17199
DEBOIS, J.-M., Calculation of the integral dose. Comparison of Cs-137 with Co-60, 17: 15569
DEBOIS, J.-M., Radiobiology and spatial navigation, 17: 16341
DE CARVALHO, H. G., Fission of U, Th, and Bi by 20-Bev protons, 17: 17180
de Castro, Orlando Euler
see Euler de Castro, Orlando
DECAUX, Bernard, Perturbations produced by high-altitude thermonuclear explosions, 17: 16272
DE CRESCENTE, M. A., Thermal decomposition of UC, 17: 15955 (PWAC-378)
DE DOMINICIS, C., Formalism of many-body problem at nonzero temperature, 17: 17072
DE FRANCISCIS, P., Effects of splenectomy in animals subjected to irradiation, 17: 15811
DE FRANCISCIS, P., Spleen factor protective against radiation syndrome, 17: 15812
DEFRANOULD, Philippe, Characteristics of thermoelectric converters, 17: 16186
DE GENNES, P. G., Nature of driving force in flux creep phenomena, 17: 16805
DE GENNES, P. G., Superconductivity in "normal" metals, 17: 16830
DEGOIS, Michel, Transformation curves of U–Cr, 17: 16671

DEHOUST, Oskar, Influence of contacts on α-induced impulses in CdS, 17: 16092
DEKHTYAR, I. Ya., Coercive force of deformed Ni alloys, 17: 16716
DEKHTYAR, I. Ya., Effects of γ radiation on deformed metals, 17: 16541
DELACHANAL, Michel, Nuclear reactors, 17: 17520
DELANGE, Maurice, Apparatus for effecting continuous solid-gas reactions, 17: 16131
DE LARA, Georges Cohen, Nuclear reactors, 17: 17520
DEL VAL COB, M., Uses of radioactive isotopes in industry, 17: 16358 (JEN-73-SI/18)
DELWICHE, R., Mass spectrometer of Laboratorie of Géologie et Géochimie Nucléaires, 17: 16385 (NP-12457)
DEMEESTER, G., Total irradiation with x rays and adrenal activity, 17: 15808
DEMEUR, M., Spectra of spherical even-even nuclei, 17: 17137
DEMINA, N. V., Photoproduction amplitude from dispersion relations, 17: 17274
DENNEY, J. M., Energy dependence of proton damage in Si, 17: 16758
DENNY, C. G., Sediment density meter, 17: 16372 (TID-18124)
DEPLANTE, J. L., Effects of size and chemical interactions, 17: 16694
DEREVYANKO, G. N., Complexometric determination of Zr and Th, 17: 15921
DE RINALDIS, P., Electrophoretic patterns of Au-198 injected into rabbit, 17: 15608
DE ROO, M., Protection by I-132 and I-133 in thyroid pathology, 17: 15568
DERRICK, M., Proton-antiproton cross sections, 17: 17006
DESAI, M. W., Determination of small amounts of long-chain aliphatic amines in aqueous solution. II., 17: 15906
DE SANTIS, V. J., Prog. rpt. on plastics and refractories, 1–3/62, 17: 16632 (AD-274654)
DE-SHALIT, A., Electromagnetic properties of atomic nuclei, 17: 17306
DESHPANDE, V. V., Apparatus for fine-particle measurement, 17: 15937 (AEET/CD/4)
DESHPANDE, V. V., Determination of particle size of ThO_2 powders, 17: 15938 (AEET/CD/5)
DESI, S., Angular distribution of γ rays from fission of U-235, 17: 17203
DE STAEBLER, H., Jr., Radiation shielding for Stanford two-mile accelerator, 17: 17318 (SLAC-9)
DE SWART, J. J., Low-energy Σ^-p and Σ^-d interactions, 17: 17025
DETKO, J. F., Prog. rpt. on electrodeless pulse plasma propulsion, final, 7/61–11/62, 17: 16771 (ASD-TDR-62-1105)
DETWEILER, R. M., Electron radiation damage in ZnSe, 17: 16757
DEUTSCH, Robert W., Nuclear rocket reactor analysis, 17: 17609
DEVLIN, L. H., Reactor core and coolant flow for EGCR, 17: 17568 (TID-18248)
DEVYATKOVA, E. D., Influence of atomic admixtures on thermal conductivity in crystalline lattice, 17: 15967 (SCL-T-468)
DEY, Arun K., Uranium(VI)–chromotropic acid chelate, 17: 16073
DIAMBRINI-PALAZZI, G., Photon and electron interactions in crystals, 17: 17179
DICK, L., Measuring polarization of positrons, 17: 17004
DICK, P. J., Isotope-generator reliability and safety, 17: 17607
DICKERSON, Ronald F., Prog. rpt. on civilian applications, 12/62, 17: 15532 (BMI-1607(Del.))
DIDIER, Daniel, Reactions (n,α) on Si-28 and Si-29 at 13.4 and 13.8 Mev, 17: 17145
DIEBNER, K., First German ship with nuclear propulsion, 17: 17579
DIETHORN, W. S., Prog. rpt. in fission gas diffusion in graphite, 6/62–5/63, 17: 16744 (TID-18112)
DIETZEL, A., Phase inversion of various ZrO_2 samples, 17: 15973
DIETZEL, A., Phase boundaries of solutions of ZrO_2 and MgO, 17: 15974
DIEULESAINT, Eugene, Characteristics of thermoelectric converters, 17: 16186
DI LAZZARO, M. A., Apparatus for detecting coincidences between low-energy photons, 17: 16426 (ISS-62/26)
DIMOCK, D. L., Use of magnetically compressed plasmas in stellarator, 17: 17326 (MATT-133)
DIOMEDE-FRESA, V., Study of granulopoietic capacity of reticulo-endothelial system by radio-Au, 17: 15607
DIRIAN, Gregoire, Regenerating alkyl-amide catalyzers used for enrichment of D, 17: 16500
DIXON, J. M., Electrical resistivity of stabilized zirconia, 17: 16683
DMITRIEFF, Anatole, Device for moving reactor control and safety rods, 17: 17516
DOBO, J., Radiochemical polymerization of cetyl methacrylate, 17: 16059
DOBROV, Yu. V., Internal bremsstrahlung β decay of Ca-45, 17: 17260
DOEDE, J. H., Absorption times of negative pions in H, 17: 17230
DOEDERLEIN, J. M., NORA—zero-power experimental reactor facility, 17: 17595 (KR-41)
DOISY, E. A., Jr., Prog. rpt. on wholesomeness of irradiated food, 7/15/61–9/1/62, 17: 16360 (NP-12597)
DOKUKINA, N. V., Phase equilibrium and properties of W–Nb–Si, 17: 16710
DOLPHIN, G. W., Dose received in 13 weeks and 50 years by body tissues, 17: 16311 (AHSB(RP)R-20)
DOMASH, Lionel, Improvement in hydrodesulfurization, 17: 16117
DONALD, Joseph M., Radiation injury to rectum and sigmoid colon, 17: 15807
DONN, William L., Detection of nuclear explosions, 17: 16904
DONNADIEU, Gerard, Heat transfer in granular media, 17: 16249
DORE, J. C., Polarization in proton–C scattering at 28 Mev, 17: 17198
DOROSHENKO, G. G., Continuous spectra of fast neutrons and γ quanta, 17: 16438
DORY, R. A., Nonlinear azimuthal space charge effects in particle accelerators, 17: 17314 (MURA-654)
DORY, Robert Allen, Space charge effects in accelerators, 17: 17322
DOTHAN, Y., Discussion of a $3^-/2$ octet, 17: 16993
DOWNING, R. G., Energy dependence of proton damage in Si, 17: 16758
DOWNS, B. W., Analysis of hypertriton by hard-core potentials, 17: 17014
DRAIN, L. E., Nuclear magnetic resonance in Cr–V alloys, 17: 16820
DRALEY, J. E., Visit to Soviet corrosion chemistry institutes, 6/25–7/4/62, 17: 16592 (TID-17940)
DRASIL, V., Radiation damage of some animal cells, 17: 15769
DRASIL, V., Sensitivity of ascites tumor to x irradiation, 17: 15722
DRATZ, Arthur F., Determination of I-131 in heterogeneous fecal specimens, 17: 15904
DRAWIN, H.-W., Spectroscopic measurements on Ti plasma gun, 17: 17380
DRAWIN, Hans-Werner, Temperature and density of plasma, 17: 17382
DRESSER, D. L., Prog. rpt. on thermionic emitter, 8/15/62–2/15/63, 17: 16773 (EDR-3207)
DREYFUS, Bernard, Nature and production of active forms of H, 17: 15864
DROBNIK, J., Effects of P-32 transmutation in yeasts, 17: 15793
DRONOVA, M. I., Determination of admixtures in alkaline metals, 17: 15923
DROZDOV, S. I., Excitation of collective states of nuclei in scattering of charged particles, 17: 17276
DU BEAU, Normand P., Nuclear activation analysis, 17: 15914
DU BOIS, Donald F., Propagation of EM waves in plasmas, 17: 17373
DU BRIDGE, R. A., In-core power monitoring of reactors, 17: 17410 (GEAP-3914)
DUBUISSON, Jacques, Making UC articles, 17: 16619
DUCHESNE, Jules, ESR and free radicals induced in DNA, 17: 15773
DUCOFFE, Arnold L., Pneumatic pressure lag. I., 17: 16232 (TID-16555)
DUDEY, Norman, Studies of $In^{115}(\alpha,2p)In^{117}$ reaction, 17: 16048 (TID-18261(p.15-18))
DUDEY, Norman, Studies of Ce^{139m}/Ce^{139} isomeric ratio formed from Ce^{140}, 17: 16054 (TID-18261(p.61-70))
DUERKSEN, J. H., Attapulgus clay for organic coolant purification, 17: 15849 (CRCE-1131)
DUGDALE, R. A., Arc initiation on heated Mo exposed to toroidal H discharge, 17: 16538
DUHAMEL, F., Rules for safety from contamination, 17: 16333 (AEC-tr-5690)
DUKAREVICH, Yu. V., Elastic low-angle scattering of fast neutrons, 17: 17097
DUNJIC, A., Influence of RNA on leukocyte level in irradiated rat, 17: 15692
DUNLAP, J. L., DCK-1 plasma experiments, 17: 17330 (ORNL-3392(p.1-10))
DUNN, Harold Searl, Small-amplitude waves in fully ionized gas, 17: 17389
DUNN, W., Lifetime of the He hypernuclei, 17: 17202
DUNWORTH, R. J., Development of Pu fuels at ANL, 17: 16571
DUORAH, H. L., Astrophysical application of 7.20(4+)–Mev state of Ne-20, 17: 16916

DUPETIT, G. A., Coprecipitation of actinides, 17: 16079
DUPLAN, J. F., Influence of x irradiation on leukemogenesis in the AKR strain, 17: 15724
DUTREIX, A., Storage of radioactive substances, 17: 16352
DUTRON, R., Symposium on calculation methods of shell structures, Brussels, 9/61, 17: 16192
DUWEZ, P., Binary alloys of rare earth metals with Au and Ag, 17: 16658 (TID-18197)
DWYER, O. E., Heat transfer to Hg flowing in-line through bundle of circular rods, 17: 16222 (BNL-6826)
DYKES, P. W., Irradiation of young male rats, 17: 15796
DYUMIN, A. N., Elastic low-angle scattering of fast neutrons, 17: 17097
DZHELEPOV, V. P., p-p Scattering at 640 Mev. Estimation of singlet phase shifts. II., 17: 17051
DZHRBASHYAN, V. A., Excitation of nuclei by slow charged particles, 17: 17267

E

EABORN, C., Radiation-catalyzed addition of organosilicon hydrides to organovinylsilanes, 17: 16068
EBERT, Heinrich Georg, Formation of ion pairs in gases by radiation, 17: 16086
EBERT, Paul Joseph, Hydrogen diffusion in metals studied by d(d,p)T reaction, 17: 17289
ECKERT, E. R. G., Turbulent boundary-layer flow longitudinal to circular cylinder, 17: 16242
EDLEN, B., Level $1s2s^3S$ of Li^+, 17: 16807
EDLUND, Milton C., Nuclear reactor and operating method, 17: 17527
EDWARDS, R. S., DCK-1 plasma experiments, 17: 17330 (ORNL-3392(p.1-10))
EECHAUTE, W., Total irradiation with x rays and adrenal activity, 17: 15808
EFIMOV, O. F., Influence of periodicity distribution on anomalous transmission of x rays, 17: 16861
EGARDT, L., Angular correlations in Λ β decay, 17: 16982
EGARDT, L., On the $\Lambda_{\mu 3}$ decay, 17: 16983
EHLER, A. W., Prog. rpt. on H_2^+ dissociation, 11/15/62–2/15/63, 17: 16793 (TID-18265)
EICHER, H., Magnetic and quadrupole moments of 8.42-kev state of Tm-169, 17: 17252
EICHER, R. N., Evaluating discordant Pb-isotope ages, 17: 16308
EICHLER, E., Stopping cross sections of low-energy tritons, 17: 17212
EIDSON, William Whelan, Alpha-induced reactions on C-12 and Ne-20, 17: 17290
ELAGIN, Yu. P., Strength functions and polarization of neutrons in optical models, 17: 17101
ELDREDGE, A. L., Design of Stanford two-mile accelerator, 17: 17316 (SLAC-7)
ELDRIDGE, O. C., Numerical experiments with a plasma model, 17: 17359
ELGER, G. W., Zirconium prepared by different reductants, 17: 16615
ELISTRATOV, A. M., Influence of periodicity distribution on anomalous transmission of x rays, 17: 16861
ELKINA, N. I., Blood serum proteins in Pu-injured dogs and rabbits, 17: 15741
EL-KINAWI, Sami A., Changes in ascorbic acid content of seeds of *Vicia faba* induced by β radiation, 17: 15716
ELKIND, Vincent, Prog. rpt. on chelating agents for urinary excretion of Sr, 12/61–12/62, 17: 15589 (TID-18058)
ELLEMAN, Thomas S., Fission-product migration in and release from Fe–20 wt % Cr, 17: 16638 (BMI-1611)
ELLINGER, F. H., Compounds of divalent lanthanides, 17: 15950 (LADC-5566)
ELLINGER, F. H., Crystal structure of beta Pu metal, 17: 16648 (LADC-5373)
ELLIOTT, J. P., Nuclear shell model and relation with other models, 17: 17305
ELLIS, F., Dose-time relationship in radiotherapy, 17: 15657
ELLIS, Thomas Gordon, Niobium–Sn–Al alloy studies, 17: 16727
ELLIS, W. P., Refractive indices of F films on UO_2, 17: 15949 (LADC-5374)
ELMENDORF, Ernest A., Radioisotope scanning for pericardial effusions, 17: 15582
ELRICK, H., Excretion of Na-22 in sweat, 17: 15700
ELSSNER, E., Measuring pressure of radioactively contaminated medium, 17: 16403
ELVING, Philip J., General equation for current-potential relationships at rotating disc electrode, 17: 15964 (TID-18263)
EMERY, G. T., Decay schemes in Os–Ir region. III., 17: 17213
ENDEBROCK, R. W., Reactor Materials, Vol. 6, No. 1, 17: 17442
ENDO, Nobuki, Blood picture and bone marrow in A-bombed survivors, 17: 15828
ENDT, P. M., Nuclear reactions. II., 17: 17281
ENGEL, R. W., Prog. rpt. on effects of irradiated diet, 9/15/62, 17: 16363 (NP-12600)
ENGLERT, F., Zero-temperature properties of many-fermion system, 17: 17031
ENOMOTO, Shigemasa, Intensification factor of Pb screen for γ radiography, 17: 17394
EPSTEIN, Harold Morton, Polarization of neutrons from $N^{14}(d,n_0)O^{15}$, 17: 17127 (TID-18256)
ERAMZHYAN, R. A., Angular distribution and polarization of recoil nuclei in capture of partially polarized μ^- mesons, 17: 17117 (JINR-P-1160)
ERICSSON, U., Atmospheric gravity waves from nuclear explosions, 17: 15538
ERIKSEN, V. O., NORA—zero-power experimental reactor facility, 17: 17595 (KR-41)
ERIKSON, R. L., Molecular radiobiology of human cell lines. III., 17: 15670
ERINGIS, K. K., Atoms with 1s and 2p electrons, 17: 16823
ERMAKOV, S. M., Energy and angular distributions of γ quanta passing through finite thickness, 17: 17466
EROKHINA, O. I., Chlorination of loparite concentrate, 17: 16024
E Silva, P. R. Paula
see Paula E Silva, P. R.
ESPAGNO, Lucien, Isotopic composition of K of different origins, 17: 16270
EULER DE CASTRO, Orlando, Corrosion resistance of construction steel, 17: 16597
EVANS, D. E., Energy distribution of multiply charged particles of cosmic rays, 17: 16929
EVANS, T. C., Radioiodine uptake studies in newborn infants, 17: 15600
EVEREST, D. A., Chemical nature of Na beryllate solutions, 17: 16002
EVTEEV, V. L., Photoproduction amplitude from dispersion relations, 17: 17274
EYRING, Henry, Prog. rpt. on liquid coolants, 1/28/61–1/31/62, 17: 16031 (TID-17275)
EZEKIEL, E. I., Determination of particle size of ThO_2 powders, 17: 15938 (AEET/CD/5)

F

FACCHINI, U., Calculations of (n,α) cross sections at 14 Mev, 17: 17206
FADDEEV, A. N., Cell division with x-ray injury of crystalline lens, 17: 15818
FAHLMAN, Anders, Auger spectra in intermediate coupling region, 17: 16810
FAIRBAIRN, A., Dose received in 13 weeks and 50 years by body tissues, 17: 16311 (AHSB(RP)R-20)
FAIRHALL, A. W., Helium ion fission of Au-197, Pb-204, and Pb-206, 17: 17224
FAIVRE, Rene, Effect of cooling rate on γ-β transformation in U–Nb, 17: 16672
FAIVRE, Rene, Transformation curves of U–Cr, 17: 16671
FALETTI, Duane W., Two-phase critical flow of steam-water, 17: 16239
FALICOV, L. M., Spin-orbit coupling in band structure of Mg, 17: 16845
FALK, David S., Equivalence of Brysk approximation and determinantal method, 17: 17011
FALK, Theodore J., Reply to comments by Probstein and Fay, 17: 17370
FALKOFF, D. L., Equilibrium in weakly interacting systems, 17: 17073
FANO, G., Canonical transformation for the Fermi gas, 17: 17062
FANO, U., Interaction matrix element in a shell model, 17: 17217
FARIS, J. P., Copper spark method for spectrographic analysis, 17: 15934
FARRELL, John Joseph, Improvements in radiation indicators, 17: 16475
FARSCHIDPUR, D., Occurrence of hypothyroidism after I-131 resection,

17: 15552
FAVRET, E. A., Radio-genetics and plant breeding, 17: 15563
FAY, H., Transient phenomena connected with capacitor banks, 17: 16782 (JUL-99-PP)
FAY, James A., Comments on "Current-Layer Diffusion in One-Dimensional Pinch", 17: 17369
FAY, James A., Partially ionized diatomic gas, 17: 16251
FEDOROV, T. F., Data on system Ti–B–Cr, 17: 16711
FEFER, A., Induction of homograft tolerance in mice, 17: 15760
FEICHTMEIR, Thomas V., Vitamin B_{12}-deficient and folic acid-deficient megaloblastic anemias, 17: 15549
FEIX, M., Numerical experiments with a plasma model, 17: 17359
FELDMAN, D. W., Prog. rpt. on vacuum techniques, annual, 1962, 17: 16181 (TID-18283)
FELICI, C., Apparatus for detecting coincidences between low-energy photons, 17: 16426 (ISS-62/26)
FELLOWS, Robert F., Chemistry of upper atmosphere, 17: 16307
FENG, P. Y., Prog. rpt. on preparing high specific activity radioisotopes, 17: 16356 (ARF-1207-9)
FENG, Paul Y., Method of making fluorinated compounds, 17: 16121
FERGUSON, A. J., Coefficients for angular correlation in nuclear bombardment, 17: 17104 (CRP-615(Rev.))
FERGUSON, I. F., Tables for correction of x-ray line breadths and peak height, 17: 15873 (AERE-R-4218)
FERNANDEZ CELLINI, R., Reaction of uranyl hydroxide with carbonic acid intermediate step in obtaining uranyl carbonate, 17: 15969
FERON, Guy, Reactions of CO_2 on U, 17: 15980
FERRARO, J. R., Infra-red spectra of salts of acidic organophosphorus compounds, 17: 16000
FERRARO, John R., Magnetic resonance studies of acidic organophosphorus compounds, 17: 16034 (TID-18170)
FERRATT, J. P., Jr., Core gas seals, EGCR, 17: 17551 (TID-18099)
FERREBEE, J. W., Irradiation and marrow infusion in leukemia, 17: 15546
FERREBEE, Joseph W., Infusion of marrow in the mouse and dog after thio-TEPA, 17: 15548
FERRILL, Mitchell D., Methyl bromide for increasing I-131 uptake by pine trees, 17: 15735
FERRO-LUZZI, Massimiliano, 1660-Mev Y_1^* hyperon, 17: 17041
FERRONI, Ferruccio, Operational experiences with Dresden reactor, 17: 17575
FESHBACH, H., Effect of earth's magnetic field on irregularities of ionization in E layer, 17: 16283
FESHBACH, H., Strange particles and parastatistics, 17: 17001
FETT, W., Recoil radiation as disturbing effect in proportional counters, 17: 16435
FETTERMAN, J. W., Acid leaching of U from South Dakota lignites, 17: 16153
FEUVRAIS, L., Measuring polarization of positrons, 17: 17004
FEYT, Jean, Transistorized pulse amplifiers, 17: 16381 (CEA-1932)
FIELDING, L. D., Standardization of γ PHA calculations at OMRE, 17: 17543 (NAA-SR-Memo-7521(Rev.))
FILLMORE, F., Effective radius of control rods, 17: 17421 (NAA-SR-Memo-477)
FILSETH, Stephen Vincent, Radicals produced in ethyl halides by irradiation 17: 16038
FINDLAY, J. R., Diffusion of fission products from graphite, 17: 16690
FINK, C. R., Isotope-generator reliability and safety, 17: 17607
FINNISTON, H. M., Metallurgical studies on Pu in Great Britain, 17: 16557
FIRSOV, O. B., Scattering of slow electrons on atoms, 17: 17269
FISCHER, J., Decomposition of PuF_6 by radiation, 17: 16045 (TID-18184)
FISCHER, J., Mechanism of the nickel–fluorine reaction, 17: 15998
FISH, Mathews B., Vitamin B_{12}-deficient and folic acid-deficient megaloblastic anemias, 17: 15549
FISHER, C. R., Prog. rpt. on Rb/Cs evaluation, 10–12/62, 17: 16768 (AGN-8075)
FISHER, D. J., Analytical instrumentation, 17: 15851 (ORNL-3397(p.1-16))
FISHER, Gerald, Prog. rpt. on spent fuel shipping, 1–3/62, 17: 16313 (EURAEC-292)
FISHER, Hymon W., Validity of radiation protection standards, 17: 16342
FISHER, John G., Materials for nuclear powerplants, 17: 16760
FISHER, P. C., Soft particle detectors, 17: 16897
FITAN, Jeannine, Method for study of multiple scattering, 17: 16815
FITE, Lloyd E., Prog. rpt. on computer coupled automatic activation analysis and remote lunar analysis, 11/62–2/63, 17: 15888 (TID-18257)
FITZPATRICK, Vincent F., Fretting corrosion of Zy-2 clad thermocouples, 17: 16588 (HW-75626)
FLEGENHEIMER, J., Rhenium isotope (2.8 hr.), 17: 17242
FLEGENHEIMER, J., Search for isomers Sr-89m and Sr-91m, 17: 17243
FLEISCHER, A. A., Analog-to-digital converter (nsec), 17: 16878
FLEM, Leon le, Reactor duct closure device, 17: 16214
FLETCHER, E. R., Interactions of K^- mesons with nuclei, 17: 17191
FLETCHER, Gilbert H., Radiation-sensitizing agents in squamous cell carcinoma, 17: 15669
FLETCHER, Stephen Baldwin Dunwich, Safety release mechanism for nuclear reactors, 17: 17515
FLINN, J. E., Jr., Fabrication procedures for high-quality tubing, 17: 16603 (ANL-FGF-409)
FLINN, Richard A., Improvement in hydrodesulfurization, 17: 16117
FLYNN, C. P., Residual resistivity due to defect pairs, 17: 16695
FOA, L., Measuring the η^0 lifetime, 17: 17184
FOLSOM, T. R., Measurement of Cs fallout in Pacific Ocean, 17: 16299
FOLSOM, T. R., Variation of Cs-137 in California coastal sea water, 17: 16300
FOMON, John J., Single dose x irradiation of lung and posterior mediastinum. III., 17: 15830
FONG, R., Rotational invariance and the S matrix, 17: 16843
FONTANA, M. H., Nuclear safety pilot plant, 17: 16328 (ORNL-3401 (p.57-60))
FONTELL, Arnos, Characteristics of h-f ion source, 17: 16800
FOOTE, Frank G., Plutonium metallurgy at ANL, 17: 16555
FORK, R. L., Media exhibiting population inversion, 17: 17374
FORMICHENKO, K. V., Effect of radiation on protein metabolism, 17: 15781
FORT, Eric, Reactions (n,α) on Si-28 and Si-29 at 13.4 and 13.8 Mev, 17: 17145
FORTH, W., Reasons for the enrichment of Cs-137 in organisms, 17: 15621
FORTIN, Antoine, Ball and socket joints for remote controls, 17: 16219
FORTIN, Marcel, Ball and socket joints for remote controls, 17: 16219
FOSSAN, D. B., Half lives of two excited states in Yb-172, 17: 17178
FOSTER, Daniel W., Synthesis of fatty acids by rat liver slices in tritiated water, 17: 15595
FOSTER, J. S., Prospects for heavy water reactors. II., 17: 17577
FOSTER, L. M., Hydrogen in Al–HP autoradiography, 17: 16539
FOSTER, Phyllis, Mitotic inhibition in rat skin resulting from β radiation, 17: 15694
FOWLER, C. M., Behavior of Fe–Si alloys under impulsive loading, 17: 16649 (LADC-5396)
FOWLER, J. F., Fractionated x-ray treatment of skin of pigs, 17: 15662
FOWLER, J. R., Dose-time relationships in radiotherapy, 17: 15658
FOWLER, T. K., Theory and computation, 17: 17335 (ORNL-3392(p.56-65))
FOX, J. G. M., X-ray determination of light elements, 17: 15908
FOX, Maurice S., Decay of P-32 in transforming deoxyribonucleate, 17: 15599
FOX, R. E., Prog. rpt. on vacuum techniques, annual, 1962, 17: 16181 (TID-18283)
FRADKIN, G. E., Effect of ionizing radiation on bacterial viruses, 17: 15791
FRAENZ, Juergen, Electron spin resonance in radiation biology, 17: 15547
FRANCES, Andre, Perturbations produced by high-altitude thermonuclear explosions, 17: 16272
FRANK, L. A., Intensity of electrons in inner radiation zone, 17: 16920
FRANK, L. A., Intensities of geomagnetically trapped particles, 17: 16924
FRANKEL, S., Search for $\mu \rightarrow e + e + e$, 17: 17026
FRANKLIN, A., Search for photoproduction of η^0 meson, 17: 16987
FRATI, W., Search for $\mu \rightarrow e + e + e$, 17: 17026
FRATIELLO, A., Kinetic study of $H_3POOH–D_2O$ exchange, 17: 15988
FREDERICK, William A., Reactor fuel handling system, 17: 17523
FREEMAN, Robert G., Carcinogenic effect of exposure to grenz ray, 17: 15823
FREID, Sheldon Henry, Fission of U-235 and U-238, 17: 17126 (TID-18165)
FREIER, P. S., Rigidity spectra for solar-flare cosmic rays, 17: 16927
FREILING, Edward C., Logarithmic correlations of fractionated radio-

nuclide compositions, 17: 16306
FRENCH, Donald Alfred, Nuclear reactor servicing machines, 17: 17480
FREUND, Peter G. O., Vector mesons and Pomeranchuk trajectory, 17: 17045
FRIAUF, R. J., Optical absorption of color centers in LiF containing Mg, 17: 15960 (TID-18146)
FRICKE, Hugo, Results from Fricke diffusion kinetics code, 17: 16502 (ANL-6560)
FRIED, Ilona, General equation for current-potential relationships at rotating disc electrode, 17: 15964 (TID-18263)
FRIED, S., Preparation and micrometallurgy of Pu metal, 17: 16553
FRIED, Z., Photon scattering in l-f high-intensity limit, 17: 17008
FRIEDEL, J., Nature of driving force in flux creep phenomena, 17: 16805
FRIEDES, Joseph Leonard, Proton spectra from p + d reaction, 17: 17085
FRIEDLAENDER, E. M., Angular distributions of muons in π^- μ decay at rest, 17: 17019
FRIEDLAND, S. S., Semiconductor detectors for space spectrometry, 17: 16895
FRIEDMAN, J. I., Determination of deuteron form factor, 17: 17020
FRIESE, K., Radiochemical polymerization of cetyl methacrylate, 17: 16059
FRISCHBIER, Hans-Joachim, Protection of eye in telecobalt therapy, 17: 15756
FRITSCH, Arnold R., Synthetic Elements. III., 17: 16085
FRITZ-NIGGLI, Hedi, European research center for radiation biology, 17: 15535 (UCRL-Trans-904)
FRITZSCHE, Walter, Ruthenium–V alloys, 17: 16717
FRONTEAU, J., Transmission through linear magnetic system of beam of primary particles, 17: 16944 (CERN-62-36)
FROST, B. R. T., Advances in liquid metal technology, 17: 16535
FRYAR, R. M., Hanford PRTR design concept, 17: 16573
FUJII, S., Reactions (p,n) and β decays, 17: 17189
FUJITA, A., Fractionation in fallout particles, 17: 16344
FUKUTA, Hajime, Blood picture and bone marrow in A bombed survivors, 17: 15828
FULINSKI, Andrzej, Statistical and thermodynamical description of correlated systems. I., 17: 16799
FULKA, Josef, Influence of radiation on nucleic acids, vitality, and fecundating ability of male sexual cells, 17: 15689
FULLER, D. D., Prog. rpt. on gas-lubricated bearings, 9–11/62, 17: 16182 (TID-18292)
FULLER, E. G., Giant resonance of nuclear photoeffect, 17: 17284
FULMER, C. B., Level structure of Ni-64 and Zn-64, 17: 17239
FULTZ, S. C., Fission cross section of U-235, 17: 17129 (UCRL-6926)
FULTZ, S. C., Photoneutron cross sections of Ta-181 and Ho-165, 17: 17227
FUNJITA, J. I., Reactions (p,n) and β decays, 17: 17189
FURCHNER, J. E., Retention of I-131 by mammalian species, 17: 15588 (LADC-5209)
FURET, Jacques, Safety precautions in pile control, 17: 17405 (CEA-2174)
FURLAN, G., Born approximation for electron and positron scattering, 17: 17186
FURUKAWA, Yoshinori, Effect of x irradiation in intestines of animals, 17: 15705
FURUTA, Tomihiko, Intensification factor of Pb screen for γ radiography, 17: 17394

G

GABRY, Andre, Perturbations produced by high-altitude thermonuclear explosions, 17: 16272
GADD, J. D., Prog. rpt. on coated Nb alloys, final, 12/21/61–12/21/62, 17: 16633 (AD-296341)
GAETANI, Soncio, Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16359 (NP-12596)
GAGER, William B., Radiolysis of the isomeric poly(butyl methacrylates), 17: 16070
GAK, D. Z., Accumulation of P-32 by water bodies, 17: 15622
GALLI, G., 2-Methylpiperazine dithioformate: liver and radio protector, 17: 15809
GALSTER, Z., Interactions of protons with heavy nuclei, 17: 17161
GAMBLE, R. L., Reducing reactor γ spectral data, 17: 16959
GAMBOYA, J. M., Uses of radioactive isotopes in industry, 17: 16358 (JEN-73-SI/8)
GANSSEN, Alexander, Nuclear maser, 17: 16908
GARATTINI, S., 2-Methylpiperazine dithioformate: liver and radio protector, 17: 15809
GARBUTT, Robert, Improvements in plugs for pipes, 17: 16211
GARDINER, Terence Edward Gouvenot, Improvements in plugs for pipes, 17: 16211
GARIN, A., Alpha particles from reaction Li-6 + Li-7, 17: 17197
GARIOD, Roger, Magnetic demagnetizing devices, 17: 16402
GARLAND, I. R., Singularities in angular momentum plane, 17: 17021
GARRISON, Warren M., Radiolysis of solid peptides, 17: 16071
GARTENHAUS, S., Particle dynamics in a bounded region, 17: 17366
GARVEI (GARVEY), N. N., Chronic radiation sickness induced by external irradiation, 17: 15805 (JPRS-18153)
GASIOROWSKI, Leslaw, Logarithmic integrator types ILG-1 and ILG-2, 17: 16391
GATES, D. C., Prog. rpt. on electrodeless pulse plasma propulsion, final, 7/61–11/62, 17: 16771 (ASD-TDR-62-1105)
GATROUSIS, Christopher, Isomeric cross-section ratios for Te^{128}(p,pn) and Te^{130}(p,pn) reactions, 17: 16049 (TID-18261(p.19-23))
GATROUSIS, Christopher, Isomeric ratios in nucleon-transfer reactions, 17: 16050 (TID-18261(p.24-6))
GAUL, G. G., Stress corrosion of Ni alloys in reactor environment, 17: 16587 (GEAP-4165)
GAUR, B. K., Radiosensitivity of maize and moisture content, 17: 15799
GAUTIER, F., Electron structure of Ni and Co alloys, 17: 16700
GAVRILYUK, V. M., Effect of electron bombardment on adsorption properties of W surfaces, 17: 16713
GEBHARDT, Erich, Oxygen adsorption on Ta layers, 17: 16719
GEBHART, B., Natural convection from vertical elements, 17: 16245
GEBHART, B., Transient natural convection on flat vertical surfaces, 17: 16246
GEHL, Mary A., Rare-earth elements in tektites, 17: 16305
GEL'D, P. V., Carbothermic reduction of Nb_2O_5, 17: 16530 (JPRS-18277)
GELLER, K. N., Threshold for Y^{88}(y,n)Y^{88} and Zr^{90}–Sr^{88} mass difference, 17: 17158
GENTNER, W., Production of beams of negative ions, 17: 17253
GEORGE, Theodore F., Inspection for underground nuclear tests, 17: 16906
GEORGIADOU, E., Lethal doses of radiation for fruit spoilage micro-organisms, 17: 16374
GERASIMOVA, N. M., Fluctuations of number of particles in electron-photon shower, 17: 16935
GERBER, Carl R., Bibliography on peaceful uses of nuclear explosives, 17: 15534 (TID-3522(Rev.6))
GERBER, G., Catabolism of nucleic acids in rat. IV., 17: 15684
GERBER, G., Catabolism of nucleic acids. V., 17: 15685
GERBER, G. B., Catabolism of nucleic acids in rat. IV., 17: 15684
GERBER, G. B., Catabolism of nucleic acids. V., 17: 15685
GERHARDS, Klaus Peter, Changes to amylose molecules of starch solution after irradiation, 17: 16087
GERSDORF, R., Ferromagnetic properties of Fe and Ni, 17: 16699
GERSTENKORN, Simon, High-resolution spectroscopy of Pu. I and II., 17: 15946 (CEA-2238)
GERSTENKORN, Simon, Magnetic moment of Pu-239, 17: 17131
GERSTENKORN, Simon, Study of Pu by high resolution spectroscopy. I., 17: 16801
GERTSRIKEN, S. D., Diffusion of Fe in Fe–Hf alloys, 17: 16546
GERVAIS, R. L., Reusable-manned-nuclear orbital carrier, 17: 17613
GEVIRTZ, R., Diagnosis of anemic states, 17: 15577
GHOSH, A. C., New isomers in Sb and I, 17: 17141
GIACOMELLI, G., Study of 224 r^{+} decays, 17: 17007
GIANNINI, M., Gamma rays from thermal neutron capture in Ho, Tm, and Lu–I, 17: 17181
GIBBONS, J. H., Capture cross sections for 30- and 65-kev neutrons, 17: 17222
GIBERT, A., Humidity measurements of building sites with radioactivity, 17: 15903
GIBSON, J. A. B., Calibration technique for determination of Rn-222, 17: 16417 (AERE-R-4165)
GIFFIN, Charles, Delayed coincidence counter for action and thoron, 17: 16440

GIGAS, Gustav, Scattering of 31-Mev protons from Pb-208, 17: 17292
GILINSKY, Victor, Propagation of EM waves in plasmas, 17: 17373
GILL, D., Stark splitting of nuclear spin levels in GaAs, 17: 17209
GILLESPIE, A. S., Jr., Hydrogen in Al–H^3 autoradiography, 17: 16539
GILLET, C., Action of x rays on *Chara vulgaris* L. III., 17: 15729
Gimeno, F., Carrasco
see Carrasco Gimeno, F.
GINSBURGH, Irwin, Gamma ray caliper, 17: 16411
GINSBURGH, Irwin, Radiation flowmeter, 17: 16405
GIORDANO, D., Activity of reticulo-endothelial system investigated with radio-Au colloids, 17: 15715
GIORDANO, D., Electrophoretic patterns of Au-198 injected into rabbit, 17: 15608
GIORDANO, D., Study of granulopoietic capacity of reticulo-endothelial system by radio-Au, 17: 15607
GLAS, Ulla, Radiosensitivity of sublines of a tumor-cell population, 17: 15688
GLASHOW, Sheldon L., Eightfold-way assignments for Y_1^*, 17: 17043
GLASS, N. W., Nitrogen-12 and B-12 β-decay measurements, 17: 17236
GLASS, Neal W., Direct comparison of the B-12 and N-12 β spectra, 17: 17237
GLEDHILL, Peter Raymond, Improvements in fluid flow indicators, 17: 16254
GLEW, G., Effect of γ radiation on β-lactoglobulin, 17: 15778
GLICK, A. J., Dielectric formulation of many-body problems, 17: 17075
GLOYNA, E. F., Temperature r'ses in radioactive wastes, 17: 17617 (LADC-5366)
GLUKHOVA, L. P., Interaction of U(VI) with arsenazo III strongly acid solutions, *17: 15931
GLYNN, John P., Suppression of homograft response, 17: 15584
GODBEE, H. W., Phosphite and hypophosphite to fix Ru from wastes, 17: 17618 (ORNL-TM-263)
GOLD, R., Matrix representation of detection systems, 17: 16429 (TID-18304)
GOLDANSKII, V. I., Quadrupole splitting in Mössbauer spectra, 17: 16013
GOLDBERG, H., Direct product of irreducible representations of SU(3), 17: 16512
GOLDEMBERG, J., Upper limit of electric dipole moment of electrons, 17: 17013
GOL'DFARB, L. M., Effect of ionizing radiation on bacterial viruses, 17: 15791
GOLDIN, Abraham, Suppression of homograft response, 17: 15584
GOLDNER, Ronald B., Intermediate state of superconductors, 17: 16871
GOLDSCHMIDT, H. J., Applications of x-ray studies in metallurgy, 17: 16667
GOLDSCHMIDT, Z., Interaction matrix element in a shell model, 17: 17217
GOLDSTEIN, Allan L., Oxidative phosphorylation in rat liver mitochondria after irradiation, 17: 15570
GOLDSWORTHY, W. W., Flexibility in amplifier design, 17: 16880
GOLOVIN, B. M., p-p Scattering at 640 Mev. Estimation of singlet phase shifts. II., 17: 17051
GOMOLCAK, Ladislav, Optical model of the atomic nucleus, 17: 17279
GONELLA, Luigi, Injection of electrons into annular machines. II., 17: 17312 (IS-522)
GORDON, G. E., Decay of Sc-42m and Ca-42 levels, 17: 17218
GORDON, Robert, Fission distribution in cluster fuel elements, 17: 17128 (UCRL-6695)
GORSHENINA, T. I., Morphologic changes in liver relative to irradiation, 17: 15817
GOSHCHITSKII, B. N., Thermo-diffusion of gas in porous medium, 17: 16491
GOULD, C. L., Fundamentals of vacuum technology, 17: 16172 (BNL-6796)
GOULDEN, Paul V., Core structure [and] bottom plate for EGCR, 17: 17565 (TID-18244)
GOULDEN, Paul V., Design of core peripheral restraints for EGCR, 17: 17557 (TID-18235)
GOUSSELAND, G., Spatial distribution of electrons around impurity, 17: 16970
GOUTIER, R., Effects of irradiation on rat liver, 17: 15785
GOYAL, D. P., Binding energies of Λ^0 hyperon in hypernuclei, 17: 17175
GRACE, J. T., Purification of H-3 by electrolysis, 17: 16489 (DP-261)
GRAETZER, Reinhard Ulrich, Double Coulomb excitation with O ions, 17: 17291
GRAFF, G., Angular distribution of γ rays from fission of U-235, 17: 17203
GRANOVSKII, Yu. V., Model for extraction of Hf and Zr with TBP, 17: 16165
GRANOVSKII, Yu. V., Optimum conditions in extraction of Hf with TBP, 17: 16166
GRANT, N. R., Fabrication of EBR-II Core I fuel elements, 17: 16602 (ANL-6276)
GRANT, Peter John, Nuclear reactors, 17: 17528
GRASHIN, A. F., Data on three-pion interaction, 17: 17050
GRAUL, E. H., Continuous measurement of radioactive fluids, 17: 16185
GRAY, M. D., Removal of I vapor from air with Cu, 17: 16008
GRAYHEK, V. G., HPD conceptual design study, 17: 17535 (GEAP-3967)
GRECHIKHIN, L. I., Effect of polarity on plasma stream of arc generator, 17: 17385
GRECHUKHIN, D. P., Magnetic dipole transitions in even nuclei, 17: 17172
GREEN, A. C., Neutron flux and energy spectrum above atmosphere, 17: 16922
GREEN, Arthur W., Jr., Magneto-telluric effects observed in Dallas, July 1962, 17: 15537
GREEN, R. E., Physics of D_2O lattices, 17: 17402 (AECL-1684)
GREENE, William J., Electron beam welding, 17: 16631
GREENLEES, G. W., Polarization in proton–C scattering at 28 Mev, 17: 17198
GREENOUGH, W. B., III, Irradiation and marrow infusion in leukemia, 17: 15546
GREENSTADT, E. W., Observations of nuclear detonation, 7/62, 17: 16298
GREENWOOD, R. C., Prog. rpt. on measurement of capture γ rays from elements, 11/62–1/63, 17: 15943 (ARF-1193-20)
GREGL, A., Metastasis frequency after x irradiation, 17: 15831
GREGORA, V., Excretion of Na by saliva after irradiation in rats, 17: 15719
GREINER, Walter, Collective potential energy in quasi-spin model, 17: 17254
GRENCH, H. A., Soft particle detectors, 17: 16897
GRENON, Michel, Nuclear reactors, 17: 17520
GRIFFEN, Allen B., Prog. rpt. on radioinduced chromosomal aberrations, 2/62–1/63, 17: 15637 (TID-18135)
GRIFFIN, C. W., Reflected reactor kinetics, 17: 16940 (NAA-SR-7263)
GRIFFITH, G. L., MHD power generation and application, 17: 16188
GRIFFY, T. A., Derivation of asymptotic expansions of exponential integrals, 17: 17133
GRIGOROV, N. L., Ionization bursts and spectrum of nuclear-active particles at mountain heights, 17: 16934
GRISHAM, J. W., Effects of divided doses of x ray on mortality and hematology, 17: 15804 (USNRDL-TR-606)
GRISON, E., Plutonium metallurgy in France, 17: 16558
GRIST, K. L., Enzyme inactivation by radiation, 17: 15783
GROSSE, A. V., Preparation and some properties of KrF_4, 17: 16021
GROUNES, M., Irradiation modifications in reactor pressure vessels, 17: 16732 (AES-2)
GROVER, J. R., Ion exchange properties of Zr phosphate, 17: 15865
GRUBER, U., Construction of bent-crystal γ spectrometer, 17: 16447
GRUBER, U., Equipment of bent-crystal γ spectrometer, 17: 16448
GRUMMITT, W. E., Strontium, Ba and Ca in human diet, 17: 15587 (CRER-1068)
GRUNZWEIG, J., Nuclear relaxation time in mixed Na salts, 17: 16018
GSCHNEIDNER, Karl, Jr., Solid solubility in metallic alloys, 17: 16518 (LADC-5380)
GUDMUNDSSON, Roland, Analytic and boundedness properties of three-point function, 17: 16824
GUENTHER, Karl Georg, Gas-analyzing method and apparatus, 17: 15935
GULYAS, Elsie, Optical rotatory dispersion of amino acids, 17: 16032 (TID-18142)
GUNCHENKO, A. I., Effect of additions of oxides on Mg–Mn ferrites, 17: 16019
GUNDERSEN, Roy M., Perturbation of MHD simple wave, 17: 16510
GUNNE, Kh. E., Statistical reliability of radioactive relay with hysteresis, 17: 16463
GUNTER, E. J., Prog. rpt. on gas-lubricated bearings, 9–11/62, 17: 16182 (TID-18292)

GUNTHER, W. H., Mechanism of the nickel–fluorine reaction, 17: 15998
GUPTA, K. P., Electron specific heat of transition elements, 17: 16698
GUREVICH, A. V., Effects induced by fast-moving artificial satellite in ionosphere, 17: 16863
GUREVICH, L. E., Kinetic properties of rarefield plasma, 17: 17384
GURINSKY, David H., Plutonium liquid-metal-fuel reactor (LMFR), 17: 16574
GURNEY, Clifford W., Effect of radiation on mouse stem cell compartment, 17: 15725
GUSAKOW, M., Density of neutrinos and antineutrinos in universe, 17: 16910
GUSTOVA, L. V., Polarization of 6,5-Mev deuterons scattered on Ti, Fe and Ni, 17: 17263
GUTHRIE, C. E., Radiochemical-plant safety, 17: 16329 (ORNL-3401 (p.63-72))
GUTHRIE, Donald A., Irradiation of polymeric compounds, 17: 16765
GUYON, E., Superconductivity in "normal" metals, 17: 16830

H

HAAS, Frank C., Catalyzing the oxidative leaching of U, 17: 16137
HAASS, Walter P., Reactional vessel, 17: 16218
HAASS, Walter P., Reactor fuel handling system, 17: 17523
HABER, Alan H., Radiation-induced mitotic inhibition, 17: 15651
HACKNEY, M. R., Isotopic analysis of UO_2 fuel irradiated in VBWR, 17: 16739 (GEAP-4107)
HAEBERLI, R., Irradiation of test pieces in Würenlingen, 17: 16754
HAEBERLI, W., Polarization from reactions, 17: 17125 (TID-18137)
HAGEN, Hans-Guenter, Leading-in plate for passing cables into reactor vessel, 17: 17512
HAGEN, Kurt, Precipitation processes in Ni–Cr alloy, 17: 16718
HAGEN, Ulrich, Viscosity of single-stranded DNA after x irradiation, 17: 15720
HAGER, E. B., Irradiation and marrow infusion in leukemia, 17: 15546
HAGINIWA, Joju, Carbon-14 in a biological environment. I., 17: 15618
HAGSTROEM, Stig, Photoelectron method of determining h/e, 17: 16809
HAHN, J., Phenothiazines treatment of radiation hangover, 17: 15832
HAHN, R. D., Uranium carbide and cladding materials for Na-cooled reactors, 17: 16650 (NAA-SR-7696)
HAHN, R. L., Internal conversion coefficients in the decay of Au-199, 17: 17238
HAHN, Yukap, Minimum principle for single-channel scattering, 17: 17029
HAIGH, Mary V., Bone-marrow treatment of irradiated rhesus monkeys, 17: 15821
HAIM, Albert, Reactions of iodopentamminecobalt(III) with various "one-electron" oxidation-reduction reagents, 17: 15987
HAJDU, J., Bloch's transport equation, 17: 16964
HAJNER, R. C., Prog. rpt. on high-pressure pump seal, 12/62–2/63, 17: 16183 (NYO-9801)
HAKURA, Y., Improving forecasts of geomagnetic storms, 17: 16290
HALBRONN, Georges, Nuclear reactors, 17: 17520
HALEVI, E. A., Secondary H isotope effects. I., 17: 15990
HALEVI, E. A., Secondary H isotope effects. II., 17: 15991
HALL, A. M., Fracture toughness of stainless steels, 17: 16640 (DMIC-Memo-164)
HALL, E. J., Heavy metal shielding in compensators for Co-60 therapy, 17: 15663
HALL, E. J., Recovery of *Vicia faba* roots from radiation, 17: 15728
HALL, James C., Oxidative phosphorylation in rat liver mitochondria after irradiation, 17: 15570
HALL, K. Lynn, Radiation chemistry of pure compounds, 17: 16097
HALL, R. R., Ion production, acceleration, and injection, 17: 17334 (ORNL-3392(p.49-55))
HALPERN, G., Cherenkov-like radiation by plasma oscillations, 17: 17341 (TID-18225)
HALPERN, J., Search for $\mu \rightarrow e + e + e$, 17: 17026
HAMADA, Kazuyoshi, Process analysis of post-activation method, 17: 15913
HAMME, John V., Prog. rpt. on U interstitial phases, 12/62, 17: 16522 (NCSC-2663-10)
HAMMER, J. J., Fuel-handling heat transfer analysis, 17: 17545 (NAA-SR-Memo-8053)
HAMMITT, Frederick G., Observation of cavitation scale in stationary and rotating components, 17: 16243
HAMPTON, Alexander, Reactions of ribonucleotide derivatives of purine analogs, 17: 15542 (TID-18138)
HAN, Hsi-I, Determination of Nb by means of lumogallion, 17: 15929
HANDLEY, Raymond, Uptake of Sr by roots of *Zea mays*, 17: 15610
HANSEN, E. H., Isotopic exchange in soil fertility studies, 17: 15581
HANSEN, L. K., Prog. rpt. on thermionic energy conversion, 11/61–10/62, 17: 16769 (AI-7979)
HANSEN, P. I., Effect of γ radiation on β-lactoglobulin, 17: 15778
HANSEN, W. R., Effects of tests in USGS Tunnel, NTS, 17: 15540
HANSON, Douglas Oliver, Actuating mechanisms for reactor control rods, 17: 17495
HAPPE, R. A., Titanium alloys which remain ductile after welding, 17: 16580
HARARI, H., Discussion of a $3^-/2$ octet, 17: 16993
HARDIE, Gerald, Scattering of protons by O, 17: 17300
HARDY, Harold Kenyon, Improvements in nuclear fuel elements, 17: 17482
HARMS, Gunter, Isotopic composition of K of different origins, 17: 16270
HARRIS, E. G., Theory and computation, 17: 17335 (ORNL-3392(p.56-65))
HARRISON, George W., Jr., Protection against ionizing radiation, 17: 15633 (SAM-TDR-62-103)
HARRITY, J. W., Prog. rpt. on radiation effects on Si solar cells, 12/61–12/62, 17: 16736 (GA-3872)
HART, James L., Inhibition of post precipitation of U in leaching process, 17: 16136
HARTSHORNE, Pierre F., Fabrication of custom gaskets, 17: 16175 (LAMS-2799)
HARVEY, D. G., Isotope-generator reliability and safety, 17: 17607
HASKIN, Larry, Rare-earth elements in tektites, 17: 16305
HATADA, Motoyoshi, Radiation-induced exchange of O in CO_2, 17: 15976
HATTORI, Kenichi, Blood picture and bone marrow in A-bombed survivors, 17: 15828
HATZIPETROU, L. P., Lethal doses of radiation for fruit spoilage micro-organisms, 17: 16374
HAWES, L. L., Dilatometry and thermal analysis of Pu metal, 17: 16561
HAWTHORNE, J. R., How neutron exposure alters reactor steels, 17: 16752
HAYASHI, Mitsuaki, Effect of γ rays on *Bacillus anthracis*, 17: 15718
HAYES, R. J., Prog. rpt. on emissivity of materials, 10–12/62, 17: 16787 (PWA-2163)
HAYMAKER, Webb, Effects of α particle radiation on rat brain, 17: 15695
HAYNIE, Thomas P., Hematologic changes following I-131 therapy, 17: 15696
HAYWARD, Evans, Giant resonance of nuclear photoeffect, 17: 17284
HAZAMA, Y., Effect of P-32 and Lu-177 upon HeLa cells, 17: 15707
HEAD, Earl L., Preparation and thermal decomposition of rare earth carbonates, 17: 15951 (LADC-5579)
HECK, G., Abdominal fusiform sarcoma after thorotrast, 17: 15711
HECKMAN, Harry H., East-west asymmetry in geomagnetically trapped protons, 17: 16918 (UCRL-10587)
HEERAN, M., π^+ Decay of He hypernucleus, 17: 17190
HEGEMANN, Johannes, Transporting heat from reactor to boiler, 17: 16259
HEILBERG, E. N., Roof-washdown radiological countermeasures, 17: 16309 (AD-297559)
HEINDL, C. J., Fission-fragment conversion reactors for space, 17: 16189
HEINZEL, Albert, Increasing D content of H, 17: 16494
HEITZ, Charles, Effect of γ radiation on diphenyl Hg, 17: 16062
HEITZ, F., Oils, lipoxidase, and radiations, 17: 15813
HEMMER, N., Monitoring by comparing ratio of two currents, 17: 16404
HEMPELMANN, L. H., Catabolism of nucleic acids in rat. IV., 17: 15684
HEMPELMANN, L. H., Catabolism of nucleic acids. V., 17: 15685
HENDRY, E. W., Pion photoproduction up to medium energies, 17: 17163
HENDRY, I. C., Fission product detector using β discrimination, 17: 16430 (TRG-Report-464)
HENICKSMAN, A. L., Determination of U in mixtures of U and W, 17: 15876 (LA-2844)
HENLE, Carye-Belle, Validity of radiation protection standards, 17: 16342
HENNESSY, James, Existence and spin of f° resonance, 17: 16965
HENNIG, R. J., Prog. rpt. on fuel re-use, 17: 17413 (HW-74549)
HENRICH, Louis R., Compression of earth's magnetic field and related phenomena, 17: 16282
HENRY, Hugh E., Pilot plant for processing irradiated nuclear fuel,

17: 16140 (DP-757)
HERBERT, I. V., Effect of cortisone and x irradiation on *Trypanosoma lewisi* infection, 17: 15573
HERBST, Roland F., Amplitudes of seismic waves from nuclear explosions in four mediums, 17: 16286
HERENGUEL, J., Prog. rpt. on preparation and irradiation of U–UC cermets, 3–6/61, 17: 16528 (EURAEC-126)
HERMAN, E. C., Jr., Irradiation and marrow infusion in leukemia, 17: 15546
HERMANN, Franz, Effects of depilatory x irradiation on hair growth in mice, 17: 15822
HERR, W., Isolation of Fr-223 on ultramarine, 17: 16160
HERSKIND, B., Half lives of two excited states in Yb-172, 17: 17178
HESS, W. N., Bomb-produced radiation belt, 17: 16875
HESSLER, N. F., Fabrication of EBR-II Core I fuel elements, 17: 16602 (ANL-6276)
HEUSINGER, H., Radiochemical changes in polymers. I., 17: 16077
HICKS, Samuel P., Radiation effects on developing nervous system, 17: 15638 (TID-18139)
HIGASHIMURA, T., Electron penetration through Al, 17: 16972
HIGGINS, George M., Experimental berylliosis. I., 17: 15598
HIGHTOWER, Nicholas C., Jr., Determining radioactivity in feces, 17: 15894
HILAL, Sadek, Suspensions of spleen and bone marrow for treatment of supralethally irradiated dogs, 17: 15845
HILBORN, J. W., Physics of D_2O lattices, 17: 17402 (AECL-1684)
HILDEBRAND, R. H., Absorption times of negative pions in H, 17: 17230
HILL, R. M., Paraelectric response of KD_2PO_4, 17: 16017
HILL, Roberto Bleiler, Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16359 (NP-12596)
HILL, W. W., Hydrogen in Al–H^3 autoradiography, 17: 16539
HILLION, Pierre, Weak interactions in the isospace H (R_2^+), 17: 16976
HILLYER, John C., Inhibition of post precipitation of U in leaching process, 17: 16136
HILSMEIER, William F., Meteorological data for Oak Ridge, 17: 16264 (ORO-199)
HILTON, John L., Parameters for fusion-powered rocket, 17: 16891
HINES, Marion, Radiation damage in muscle cell membranes, 17: 15641 (TID-18221)
HINKLE, J. G., Prog. rpt. on gas-lubricated bearings, 9–11/62, 17: 16182 (TID-18292)
HINTZ, E., Transient phenomena connected with capacitor banks, 17: 16782 (JUL-99-PP)
HINZ, I., Phase inversion of various ZrO_2 samples, 17: 15973
HINZ, I., Phase boundaries of solutions of ZrO_2 and MgO, 17: 15974
HINZPETER, G., Sub-normal low-pressure glow discharge, 17: 16802
HIRAOKA, Takaya, Process analysis of post-activation method, 17: 15913
HIRATA, Haruyoshi, Internal conversion of 1277-kev transition in Ne-22, 17: 17170
HIRAYAMA, Toru, Process analysis of post-activation method, 17: 15913
HIROTA, Kozo, Catalyst factor in exchange of paraxylene with D_2O, 17: 15863
HIROTA, Kozo, Radiation-induced exchange of O in CO_2, 17: 15976
HIRTZ, Alfred, Liquid moderator reactors, 17: 17499
HISKES, John R., Inverted cascades in neutral injection systems, 17: 17342 (UCRL-7115)
HITSUMOTO, Satoshi, Blood picture and bone marrow in A-bombed survivors, 17: 15828
HLAD, C. J., Jr., Excretion of Na-22 in sweat, 17: 15700
HOALST, K. M., Dosimetry of space radiations, 17: 16452
Hoan Nguyen Ngoc
see Ngoc, Hoan Nguyen
HOBBS, Doreen Y., Thorium phosphate phosphors, 17: 16684
HOCH, Michael, Thermal conductivity of molded and pyrolytic graphites, 17: 16678
HODGSON, P. E., Symmetry term in nuclear optical potential, 17: 17204
HODGSON, R. A., Sediment density meter, 17: 16372 (TID-18124)
HOECKER, Karl H., Neutronic reactor and fuel element therefor, 17: 17503
HOEGDAHL, Ove T., Neutron absorption in pile neutron activation analysis, 17: 15877 (MMPP-226-1)
HOEKSTRA, Henry R., Uranium–oxygen bonding in uranates, 17: 15959 (TID-18140)
HOEMIG, H. E., Corrosion of Fe in neutral and alkaline waters, 17: 16600
HOERNFELDT, Olle, Auger spectra in intermediate coupling region, 17: 16810
HOERNFELDT, Olle, Photoelectron method of determining h/e, 17: 16809
HOFMANN, F., Method for producing UO_2 powder, 17: 16132
HOFMANN, P. L., Prog. rpt. on fuel re-use, 17: 17413 (HW-74549)
HOFMANN, P. L., Utilization of Pu for special reactor applications, 17: 16517 (HW-SA-2872)
HOHMANN, H., X radiation in fission of U-235, 17: 17250
HOHMANN, Jens, Fixation of radioactive elements by mineral coals, 17: 15968
HOLBROW, Charles Howard, Neutrons from protons on Ni, Rh, Ta, and Au, 17: 17293
HOLLAND, M., Lifetime of the He hypernuclei, 17: 17202
HOLLEY, Charles E., Jr., Combustion in a bomb of metal, 17: 15933
HOLLEY, Charles E., Jr., Preparation and thermal decomposition of rare earth carbonates, 17: 15951 (LADC-5579)
HOLLOWAY, L., Search for $\mu \rightarrow e + e + e$, 17: 17026
HOLOEIEN, Erling, States of two-electron atomic systems, 17: 16835
HOLSOPPLE, H. L., Jr., Organic preparations, 17: 15860 (ORNL-3397 (p.113-16))
HOLT, A. B., Survey of 21 reactor vessels, 17: 16743 (TID-17682)
HOLTZ, F. C., Prog. rpt. on V alloys, 12/14/62–2/13/63, 17: 16514 (ARF-B6007-1)
HOLTZ, F. C., Prog. rpt. on improved Zr alloys, 10–12/62, 17: 16582 (ARF-B198-36)
HONES, Edward W. Jr., Motions of charged particles trapped in earth's magnetosphere, 17: 16921
HONJO, Ichijiro, Chemical protection of lymphatic cells against γ irradiation, 17: 15833
HONJO, Ichijiro, Deoxyribonucleoprotein of mouse spleen irradiated with γ rays, 17: 15706
HOOPER, J. R., Sr., Prog. rpt. on heat rejection in space power plants, 9–11/62, 17: 16230 (PWA-2132)
HOOPER, J. W., Atomic collisions in space phenomena, 17: 16886
HOOPER, J. W., Prog. rpt. on ionization of alkali ions, 12/62–2/63, 17: 16792 (TID-18258)
HOPKINS, B. J., Strontium-90 in hair, 17: 15612
HOPKINS, H. W. K., Deuteron-deuteron scattering at 20 to 70 Mev, 17: 17010
HOPKINS, H. W. K., Proton-deuteron interactions at 77 Mev, 17: 17009
HOPKINSON, E. C., Instrumentation for lunar surface analysis, 17: 16894
HOPPER, V. D., Comment on paper "Cosmic-ray variations during IGY," 17: 16923
HORI, H., Prog. rpt. on thermionic energy conversion, 11/61–10/62, 17: 16769 (AI-7979)
HORIE, H., Cluster model in $Ne^{20}(\alpha,C^{12})C^{12}$, 17: 17195
HORIYE, H., Prog. rpt. on radiation effects on Si solar cells, 12/61–12/62, 17: 16736 (GA-3872)
HORNI, Edward C., Pilot plant for processing irradiated nuclear fuel, 17: 16140 (DP-757)
HORNICK, Richard B., Studies of the reticuloendothelial system. II., 17: 15572
HORSSBY, J., Transmission through linear magnetic system of beam of primary particles, 17: 16944 (CERN-62-36)
HORTIG, G., Production of beams of negative ions, 17: 17253
HORTON, C. A., Infrared studies, 17: 15862 (ORNL-3397(p.121-3))
HORTON, G. R., Solvated 8-quinolinol and 2-methyl-8-quinolinol chelates of thorium(IV), 17: 16004
HORWITZ, G., Zero-temperature properties of many-fermion system, 17: 17031
HORWITZ, N., K^- interactions in D: n^-pY final states, 17: 16981
HOSLER, E. R., Boiling water at high pressure, 17: 16235 (WAPD-T-1566)
HOSOE, M., X-ray dose absorbed by soft tissue near bone, 17: 15702
HOSTETLER, R. L., Neutron flux and energy spectrum above atmosphere, 17: 16922
HOTTA, Akio, Elastic scattering of photons. II., 17: 17153
HOUGH, Paul V. C., Fast analysis system for bubble chamber data, 17: 16419 (BNL-6871)
HOWE, Clifton D., Radiation-sensitizing agents in squamous cell carcinoma, 17: 15669
HOWES, James E., Jr., Fission-product migration in and release from

Fe–20 wt % Cr, 17: 16638 (BMI-1611)
HOYAUX, Max, Thermonuclear reactions. Future energy sources, 17: 17378
HRADECNA, Z., Effect of radiation on phage *lambda*, 17: 15790
HSU, Cho'n-man, Effects of neutrons on winter wheat, 17: 15748
HU, C. H., Utilization of x-ray radiation for rice, 17: 15564
HUBBARD, Arthur C., Detection of nuclear explosions, 17: 16904
HUBBARD, Lyle, Radioactivity in large marine plankton, 17: 15609
HUBER, Elmer J., Jr., Combustion in a bomb of metal, 17: 15933
HUBER, H., Field reversal in tenuous plasma, 17: 16790 (TID-18216)
HUDNIK-PLEVNIK, T. A., Nucleic acids after uv irradiation, 17: 15777
HUDOKLIN, A., Radiative capture of 14-Mev neutrons in Al-27, 17: 17207
HUDSON, R. G., Prog. rpt. on carbide cathode studies, final, 1/30/63, 17: 16774 (GA-3642)
HUDSON, R. G., Prog. rpt. on carbides for thermionic space reactors, 11/30/62, 17: 16516 (GA-3866)
HUECK, Walter, Deformation of Al single crystals, 17: 16720
HUERGO, M. E., Search for isomers Sr-89m and Sr-91m, 17: 17243
HUERLIMANN, Th., Irradiation of test pieces in Würenlingen, 17: 16754
HUES, A. D., Determination of U in mixtures of U and W, 17: 15876 (LA-2844)
HUET, Andre, Improvements in nuclear reactors, 17: 17491
HUET, Andre, Light boiler for nuclear energy installation, 17: 16258
HUET, Andre, Reactor with fuel under spheroidal form, 17: 17500
HUET, Henri, Apparatus for effecting continuous solid-gas reactions, 17: 16131
HUGHES, M. P., Catalog of solar radio bursts, 17: 16912
HUGHES, Vernon W., Electron-proton charge difference and charge of neutron, 17: 17012
HUIZENGA, J. R., Nuclear fission, 17: 17283
HULUBEI, H., Angular distributions of muons in $\pi^- \mu$ decay at rest, 17: 17019
HUMMER, David G., Non-coherent scattering. I., 17: 16973
HUMMON, Margaret R., Effects of tritiated thymidine incorporation on secondary root production, 17: 15653
HUMPHREYS, Stewart R., Suppression of homograft response, 17: 15584
HUNG, Shui-chieh, Separation and determination of Th and Sc, 17: 15909
HUNG-KUEI, Su, Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
HUNTER, Neville John, Radiation-resistant lubricants, 17: 15866
HUNTER, Neville John, Radiation-resistant lubricants, 17: 16764
HUTCHINGS, M. T., Crystalline electric field effects on rare earth ions. I., 17: 15941 (AFCRL-62-945)
HUTCHINSON, F., Action of radiation on DNA, 17: 15764
HUTCHINSON, F., Energy loss of electrons, 17: 15765
HUWE, Darrell O., Spin and parity of Y_1^* resonance, 17: 17040
HUXTABLE, G. B., Scattering of neutrons by U from 18 to 120 Mev, 17: 17159
HVINDEN, T., Fallout in Norwegian milk in 1961, 17: 15614 (A/AC.82/G/L.810)
HYAMS, B. D., Scattering of 8-Bev μ mesons on electrons, 17: 17017
HYATT, E. C., Respirators for protection against airborne radioactive contaminants, 17: 16316 (LADC-5410)
HYATT, E[dwin] C., Problems and developments in respiratory protection, 17: 16314 (LADC-5343)
HYETT, B. Joanne, Boundary of geomagnetic field in steady solar wind, 17: 16291

I

IBERT, Edward, Prog. rpt. on computer coupled automatic activation analysis and remote lunar analysis, 11/62–2/63, 17: 15888 (TID-18257)
ICHIKI, S. K., Paraelectric response of KD_2PO_4, 17: 16017
IDDINGS, C. K., Low-energy Σ^-p and Σ^-d interactions, 17: 17025
IIO, Masahiro, Studies of the reticuloendothelial system. I., 17: 15571
IIO, Masahiro, Studies of the reticuloendothelial system. II., 17: 15572
IIZUKA, Muneo, Sex chromosome translocations in *Spinacia oleracea*, 17: 15682
IKEDA, K., Reactions (p,n) and β decays, 17: 17189
IL'IN, V. P., Resonance capture of neutrons in annular trap, 17: 17469
ILLARIONOV, S. V., Optical constants of LaB_6 and CeB_6, 17: 16714
ILLING, Derek, Radiation-resistant lubricants, 17: 16764
ILTIS, T. J., Radioactive luminous material hazard, 17: 16338
IMAZU, Shingo, Helical instability in positive column in magnetic field, 17: 17352
IMHOF, W. L., Instrumentation for space radiation. II., 17: 16893
INADA, T., Capture cross sections for 30- and 65-kev neutrons, 17: 17222
INFELD, L., "Uniformly accelerated" motion and relativity, 17: 16798
INGRAM, Glenn Raymond, Invariant bedding and neutron transport in slabs, 17: 17103
INOUYE, G. T., Observations of nuclear detonation, 7/62, 17: 16298
IONESCO-PALLAS, N. J., Theory of second-order isotope shift, 17: 16803
IOSILEVSKII, Yu. A., Mössbauer effect for impurity nucleus. II., 17: 16868
IRISH, E. R., Prog. rpt. on radioactive residues, 10–12/62, 17: 17615 (HW-76262)
IRVINE, J. W., Homografts in dog after lethal irradiation, 17: 15814
IRVINE, John W., Jr., Excitation functions and yields: Zn + d and $Ar^{40}(d,\alpha)$, 17: 17235
IRVINE, John W., Jr., Nuclear excitation functions: Ar-40, Zn-68(d,He-3), 17: 17234
IRVINE, W. R., Creep deformation of stoichiometric UO_2, 17: 16687
IRVING, H., Adsorption of anionic complexes on cation-exchange resin, 17: 15992
IRVING, H., Metal complexes of *N*-(2-pyridylmethyl)iminodiacetic acid, 17: 15993
ISAEV, L. N., Sputtering of mica and quartz by Kr ions, 17: 16817
ISBIN, H. S., Prog. rpt. on heat transfer, 12/62–1/63, 17: 16233 (TID-18141)
ISHIMORI, Tomitaro, Complex compounds of NP(IV), 17: 16075
ISHIMORI, Tomitaro, Separation of U, Pu, and fission products by multistage extraction, 17: 16158
ISHIZUKA, Takeo, Photoprotons from S-32, 17: 17155
ISLAMOV, A. A., Lifetime of 0.845-Mev level in Fe-56, 17: 17265
ISMATOV, E., Splitting of deuteron in field of deformed nuclei, 17: 17247
ISOYA, Akira, Levels of Er and W isotopes, 17: 17232
ISRAEL, M. H., Absorption times of negative pions in H, 17: 17230
ITO, Morio, Blood picture and bone marrow in A-bombed survivors, 17: 15828
ITZYKSON, C., One-particle exchange in antiproton collisions in flight, 17: 16984
ITZYKSON, C., Spin and parity of hyperon isobars, 17: 16995
IUCCI, N., Spectral variation of primary cosmic rays during Forbush decreases, 17: 16930
IVANITSKII, P. G., Angular distribution of α particles from $Be^9(d,\alpha)Li^7$, 17: 17245
IVANOV, V. I., Dosimetry and radiation protection, 17: 16353
IVANOVA, I. K., Absolute age of paleolithic period by radiocarbon dating, 17: 16273
IVANOVA, S. P., Cross section for compound-nucleus formation, 17: 17118 (JINR-P-1162)
IVANOVA, S. P., Elastic scattering of heavy ions, 17: 17115 (JINR-P-1153)
IVASHCHENKO, N. I., Heat transfer in turbulent flow, I and II, 17: 16236 (AERE-Trans-911(Pts.1 & 2))
IWAKURA, Tetsuo, Carbon-14 in a biological environment. I., 17: 15618
IWAKURA, Tetsuo, Carbon-14 and H-3 measurement by liquid scintillation spectrometer. II., 17: 16457
IWAKURA, Tetsuo, Carbon-14 and H-3 measurement by liquid scintillation spectrometer. III., 17: 16458
IWASAKI, T., Radioactive contamination in organs of humans, 17: 16346
IYENGAR, Kalkunte Vedanthachar Krishna, Polarization produced in elastic scattering of 2.8-Mev neutrons, 17: 17294
IYENGAR, T. S., Estimation of T by gas-phase counting, 17: 15871 (AEET/HP/TM-10)
IZAWA, Masami, Cesium-137 concentration in human urine, 17: 16343
IZRAILEVICH, I. S., Thermo-diffusion of gas in porous medium, 17: 16491
IZUMI, Y., Effects of relative humidity on film emulsion, 17: 16459

J

JACK, John R., Nozzle performance for orbital-launch nuclear rockets, 17: 17606 (NASA-TN-D-1578)
JACK, T. H., Hydrogen in Al–H^3 autoradiography, 17: 16539
JACKSON, P. M., Burst test unit for irradiated pressure tubes, 17: 16740 (HW-76158)
JACOB, M., One-particle exchange in antiproton collisions in flight,

17: 16984
JACOB, M., Spin and parity of hyperon isobars, 17: 16995
JACOBS, Alan S., Association of radioactive Cr with various components of hemoglobin, 17: 15593
JACOBS, J. J., Cesium separation by AMP process. IV., 17: 16139 (AERE-R-4245)
JACOBS, Robert B., Radiation flowmeter, 17: 16406
JACOBY, H. I., Preparation of H^3-labeled normorphine and physiology, 17: 15601
JAFFE, A. M., Asymptotic behavior of S matrix for high angular momentum, 17: 17023
JAFFE, Leonard D., Interstellar travel, 17: 17603 (JPL-TR-32-233)
JAFFEE, R. I., Titanium alloys which remain ductile after welding, 17: 16580
JAMES, D. B., Processing of Pu by ion exchange. I., 17: 16143 (LADC)
JAMES, D. B., Synergistic effect of Th on distribution coefficients of elements with anion-exchange resin, 17: 15948 (LA-2836)
JAMIESON, D., Metabolic factors in radioprotective action, 17: 15794
JANCEL, Raymond, Electron distribution function of plasma, 17: 17347
JANICK, Jules, Sex chromosome translocations in *Spinacia oleracea*, 17: 15682
JANKOVIC, V., Liver DNA injected into lethally-irradiated rats. I., 17: 15797
JANNUSSIS, A., Thermal neutron spectrum in absorbing medium, 17: 17095
JANOUCH, F., Lectures on topics in nuclear theory, 17: 17302
JARRY, R. L., Mechanism of the nickel–fluorine reaction, 17: 15998
JASTRZEBSKI, J., Angular distributions in (d,α) reactions, 17: 17171
JASTRZEBSKI, J., Transition probabilities in excited states in Au-193, Au-195, and Au-197, 17: 17193
JEAN, A. G., Detection of high-altitude detonations, 17: 16900
JEFFERSON, Sidney, Gamma ray thickness gages, 17: 16407
JELINEK, H. F., Fabrication of EBR-II Core I fuel elements, 17: 16602 (ANL-6276)
JELLY, Doris H., Effects of PCA on h-f oblique-incidence circuits, 17: 16295
JENKINS, G. M., Electron microscope studies of graphitization and deformation in C film, 17: 16692
JENKINS, Theodore, Argon–He scintillation, 17: 16794 (UCRL-10523)
JENKINS, W. J., Sulfamic acid for dissolving Pu, 17: 15957 (TID-16387)
JENKINS, William J., Pilot plant for processing irradiated nuclear fuel, 17: 16140 (DP-757)
JESSE, Richard H., Jr., Radiation-sensitizing agents in squamous cell carcinoma, 17: 15669
JIRU, P., Exchange reactions of O-18 with oxidation catalysts. I., 17: 15979
JOERGENSEN, J. A., Isotopic exchange in soil fertility studies, 17: 15581
JOFTES, David L., Radioautography, principles and procedures, 17: 15698
JOHANSSON, Lennart, Spectrum of neutral Be atom, 17: 16808
JOHNS, O. D., Prog. rpt. on electrodeless pulse plasma propulsion, final, 7/61–11/62, 17: 16771 (ASD-TDR-62-1105)
JOHNSON, Ann, Contamination of milk by radioiodine, 17: 15605
JOHNSON, B. Connor, Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16359 (NP-12596)
JOHNSON, B. S., Jr., Purification of H-3 by electrolysis, 17: 16489 (DP-261)
JOHNSON, Ben S., Low-temperature still for separation of H isotopes, 17: 16490 (DP-732)
JOHNSON, D. E., Prog. rpt. on carbides for thermionic space reactors, 11/30/62, 17: 16516 (GA-3866)
JOHNSON, E., Analog-to-digital converter (nsec), 17: 16878
JOHNSON, G. R. A., Nitrous oxide radiation dosimeter, 17: 16441
JOHNSON, James R., Thermally resistant articles and fabrication, 17: 16628
JOHNSON, N. R., Stopping cross sections of low-energy tritons, 17: 17212
JOHNSON, R. L., Bibliography on kinetics, stability, and control, 17: 17420 (NAA-SR-7786)
JOHNSSON, S., Adsorption of radioactive rare earths, 17: 16149 (CEA-tr-A-1230)
JONES, B. E., Role of film badge in personnel monitoring, 17: 16432
JONGEJANS, B., Scattering and absorption of π^- in nuclear emulsion, 17: 16980
JONKER, William Abraham Adolf Jacobus, Feedwater temperature control of turbine plants, 17: 16198
Jorba, Jean Perez y
see Perez y Jorba, Jean
JOUIN, Jacques, Reactor duct closure device, 17: 16214
JOURDAN, Ph., Behavior of plasma produced by button-type source, 17: 17360
JOVICKI, G., Liver DNA injected into lethally-irradiated rats. I., 17: 15797
JUCYS, A. P., Atoms with 1s and 2p electrons, 17: 16823
JUDD, Brian R., Operator techniques in atomic spectroscopy, 17: 16907
JUHASZ, Sandor, Fixation of radioactive elements by mineral coals, 17: 15968
JUN, Mu, γ Production in interaction of π^- mesons with nuclei, 17: 17192
JURA, George, Transition in Yb, 41 kilobar, 17: 16662 (UCRL-10332)
JURCSIK, Istvan, Fixation of radioactive elements by mineral coals, 17: 15968

K

KABACHENKO, A. P., Internal bremsstrahlung β decay of Ca-45, 17: 17260
KACSER, Claude, 3π Decay modes of K and η, 17: 17027
KACZMAREK, U., Selection and application of G-M counters, 17: 16443
KAEFER, Ema, Radiation effects in *Aspergillus nidulans* diploids, 17: 15679
KAERCHER, G. C., Model studies of reactor coolant and fuel pin behavior, 17: 17556 (TID-18229)
KAGAN, Yu., Mössbauer effect for impurity nucleus. II., 17: 16868
KAGANSKII, M. G., Positron decay of Re-182, 17: 17259
KAHALAS, S. L., Frequency cutoff hydromagnetic waves in upper atmosphere, 17: 16296
KAHALAS, Sheldon L., Coupling of waves at plasma discontinuity. II., 17: 17363
KAHAN, Theo, Electron distribution function of plasma, 17: 17347
KAIPOV, D. K., Lifetime of 0.845-Mev level in Fe-56, 17: 17265
KALASHNIKOV, A. G., Calculations of fuel burnup in reactors, 17: 17464
KALININA, N. A., Reparation following x-ray exposure at antenatal period, 17: 15745
KALINKIN, B. N., Cross section for compound-nucleus formation, 17: 17118 (JINR-P-1162)
KALINKIN, B. N., Elastic scattering of heavy ions, 17: 17115 (JINR-P-1153)
KALKSTEIN, M. I., Test detection by nuclear chemistry, 17: 16903
KALLENBACH, H., Metastasis frequency after x irradiation, 17: 15831
KALVIUS, M., Magnetic and quadrupole moments of 8.42-kev state of Tm-169, 17: 17252
KALYAMIN, A. V., Regularities in α decay of nuclei with less than 126 neutrons, 17: 17256
KAMATA, Koichi, Measurements of slow neutrons in Pacific and Indian Oceans, 17: 16933
KAMATANI, Tomonori, Blood picture and bone marrow in A-bombed survivors, 17: 15828
KAMEDA, Kazuhisa, Rare earth elements in marine organisms, 17: 15604
KAMINSKII, D. L., Positron decay of Re-182, 17: 17259
KANAZIR, D. T., Effects of x irradiation on RNA metabolism in rat liver, 17: 15798
KANAZIR, D. T., Liver DNA injected into lethally-irradiated rats. I., 17: 15797
KANAZIR, D. T., Nucleic acids after uv irradiation, 17: 15777
KANDYBAROV, V. K., Beta stability of heavy elements, 17: 17148
KANE, R. P., Energy spectrum of variations of cosmic ray daily mean intensity, 17: 16931
KANE, W. R., Decay schemes in Os–Ir region. III., 17: 17213
KANEKO, Shobu, Transport coefficients of a magnetoplasma, 17: 17351
KAPLAN, B. Ya., Determination of Sc in coal ash, 17: 15920
KAPLAN, I. G., Calculation of esergy matrix for identical particles, 17: 17058
KAPLAN, Irving, Prog. rpt. on D_2O lattice project, annual, 9/62, 17: 17419 (MITNE-26)
KAPLAN, N., g-Factor of 2.083-Mev 4⁺ state of Ce-140, 17: 17194
KAPLAN, S. J., Behavior of rats resulting from fetal x irradiation, 17: 15655
KAPLYANSKII, A. A., Spectra of crystals of alkali fluorides with U,

17: 15981
KAPLYANSKII, A. A., Spectra of alkali-earth fluoride crystals, 17: 16012
KAPOOR, R. N., Quinquevalent compounds of U. III., 17: 15994
KARABAEV, E. M., Influence of post-irradiation conditions on effects on yeast cells, 17: 15739
KARETZKY, M., Infusion of marrow in the mouse and dog after thio-TEPA, 17: 15548
KARKHANAVALA, M. D., Apparatus for fine-particle measurement, 17: 15937 (AEET/CD/4)
KARKHANAVALA, M. D., Determination of particle size of ThO_2 powders, 17: 15938 (AEET/CD/5)
KARMYSHEVA, Yu., Oocyte maturation division in acute radiation, 17: 15816
KARPFEL, Z., Effect of DNA on chromosomal aberrations in bone marrow, 17: 15788
KARRAKER, D. G., Purification of H-3 by electrolysis, 17: 16489 (DP-261)
KASAKURA, S., Infusion of marrow in the mouse and dog after thio-TEPA, 17: 15548
KASHCHENKO, L. A., Radiation injuries of ovulation mechanism in frogs, 17: 15743
KASHIWAGI, Michio, Radiation damage in oriented polyamides, 17: 16069
KASIDA, Yoshiko, Carbon-14 in a biological environment. I., 17: 15618
KASIDA, Yoshiko, Carbon-14 and H-3 measurement by liquid scintillation spectrometer. II., 17: 16457
KASIDA, Yoshiko, Carbon-14 and H-3 measurement by liquid scintillation spectrometer. III., 17: 16458
KASTEN, Ronald Robert, Cosmic ray pion-muon cascade, 17: 16938
KATSURAKI, Hisao, Neutron diffraction study of κ phase Cu–Mn–Al alloys, 17: 16702
KATZ, A., Convergence and analytic properties of linked-cluster expansion, 17: 17074
KATZ, J., Mass spectrometer of Laboratorie of Géologie et Géochimie Nucléaires, 17: 16385 (NP-12457)
KATZ, L., Proton radiation dosage in vehicle in trapped belt, 17: 16876
KATZ, O. M., Prog. rpt. on vacuum techniques, annual, 1962, 17: 16181 (TID-18283)
KATZENSTEIN, H. S., Semiconductor detectors for space spectrometry, 17: 16895
KATZIN, Leonard I., Optical rotatory dispersion of amino acids, 17: 16032 (TID-18142)
KAUFMAN, Aaron, Delayed coincidence counter for action and thoron, 17: 16440
KAULEN, D. R., Bone marrow chimeras of guinea pigs, 17: 15839
KAWAMURA, Nobuaki, Photoprotons from S-32, 17: 17155
KAY, A. E., Physical and physicochemical properties of Pu, 17: 16564
KAYSER, P., Hazards of ionizing radiations, 17: 16337
KAYUSHIN, L. P., Free radicals in rat liver lipids after γ irradiation, 17: 15672
KAZARINOV, Yu. M., Conformal mapping in scattering of high-energy particles, 17: 17054
KAZASSKII, Yu. A., Gamma spectra in capture of thermal and fast neutrons, 17: 17255
KEATEN, R. W., Reflected reactor kinetics, 17: 16940 (NAA-SR-7263)
KEBERLE, Edward M., Explicit solutions of partial difference equations and random paths on plane nets, 17: 16509
KEDER, W. E., Extraction of actinides from HCl, 17: 16156
KEEFE, D., Elastic K^+-proton scattering, 17: 17015
KEESOM, P. H., Specific heat of Pb from 0.3 to 4°K, 17: 16834
KEHLER, Paul, Activation analysis of ocean bottom cores, 17: 15886 (TID-18125)
KEIL, Horst, Oxygen adsorption on Ta layers, 17: 16719
KELLENBERGER, G., Effect of radiation on phage *lambda*, 17: 15790
KELLEY, M. T., Analytical instrumentation, 17: 15851 (ORNL-3397 (p.1-16))
KELLEY, M. T., Inorganic preparations, 17: 15859 (ORNL-3397(p.112-13))
KELLEY, Raymond H., Electron processing of semiconducting material, 17: 16581
KELMAN, L. R., Development of Pu fuels at ANL, 17: 16571
KLEPIKOV, N. P., Necessary experiment in p-p scattering, 17: 17057
KEMP, Nelson H., Partially ionized diatomic gas, 17: 16251
KENCH, J. R., Collapse in alpha U subjected to thermal cycles, 17: 16689
KENDALL, H. W., Determination of deuteron form factor, 17: 17020
KENDALL, H. W., Electron scattering studies: Cu-63, In-115, Ta-181, Pb-208, and Bi-209, 17: 17233
KENNEDY, C. R., Effect of stress state on high-temperature low-cycle fatigue, 17: 16654 (ORNL-3398)
KERN, Eberhard, Reflector effects on temperature coefficient of reactors, 17: 17430
KERTH, L. T., Elastic K^+-proton scattering, 17: 17015
KESEL, G. P., Glove box design for Pu reclamation facility, 17: 16141 (HW-68442)
KETZLACH, Norman, Nuclear safety in Hallam UC fuel shipment, 17: 16317 (NAA-SR-Memo-8151)
KHALEZOVA, E. B., Ratio ZrO_2/HfO_2 in zircons, 17: 16275
KHARADZHA, F. N., Vacuum chamber for measuring x and γ high dosage rates, 17: 16436
KHARCHENKO, V. F., Polarization in direct nuclear reactions, 17: 17244
KHARITONOV, Yu. I., Level with spin I = 16 in Po-212, 17: 17271
KHMELEVA, N. N., Accumulation of Sr, Ca, Ce, and Y by crustacea, 17: 15623
KHOLIN, V. V., Determination of absorbed x-ray doses in animals, 17: 16350
KHOMYAKOV, A. P., Total content and composition of rare earths in minerals, 17: 16278
KHRAPOV, V. V., Quadrupole splitting in Mössbauer spectra, 17: 16013
KHRENOVA, R. A., Photoproduction amplitude from dispersion relations, 17: 17274
KHURI, N. N., Extension of the Regge representation, 17: 17033
KHURI, N. N., Nucleon as a Regge pole, 17: 17038
KHVOSTOVA, V. V., Effects of neutrons on winter wheat, 17: 15748
KIBLER, G. M., Prog. rpt. on plastics and refractories, 1–3/62, 17: 16632 (AD-274654)
KIEHN, R. M., Role of Pu in nuclear power, 17: 16569
KIENLE, P., Magnetic and quadrupole moments of 8.42-kev state of Tm-169, 17: 17252
KIESEL, Kenneth A., Radio fluid detector, 17: 16482
KILDAL, A., Hydromagnetic fluid motion generated by oscillating boundaries. I., 17: 17397
KILIBARDA, M. Dj., Irradiation of young male rats, 17: 15796
KILPATRICK, W. D., Cesium electron bombardment ion motor, 17: 16873
KIM, Chong Kuk, Thermal neutron activation analysis of Ti, 17: 15884 (TID-16522)
KIM, Y. S., Asymptotic behavior of S matrix for high angular momentum, 17: 17023
KIM, Young Sik, High-energy photoprotons from light nuclei, 17: 17295
KIMURA, Motoharu, Elastic scattering of photons. II., 17: 17153
KIMURA, Motoharu, Photoprotons from S-32, 17: 17155
KING, Irving R., Preparation of high-purity single-crystal B, 17: 16635 (ASD-TDR-62-427)
KINGSBURY, F. D., Neutron irradiation effects in A-286, Hastelloy X and René 41, 17: 16745 (TID-18150)
KINSEY, R. P., British plans for nuclear ships, 17: 17580
KINTNER, L. L., Cooling requirements for fuel assemblies, EGCR, 17: 17552 (TID-18101)
KIOBLOKH, V., Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
KIOES, C., Hazards of ionizing radiations, 17: 16336
KIRCHER, John F., Enhanced catalytic activity from irradiation of catalysts, 17: 16040 (BMI-1620)
KIRCHER, John F., Radiolysis of the isomeric poly(butyl methacrylates), 17: 16070
KIRCHNER, Henry P., Thermal expansion of UP_2O_7, 17: 16680
KIRILLOVA, L. F., Elastic p-p scattering at 8.35 Bev, 17: 16950 (JINR-P-1135)
KIRK, P. L., Preparation and micrometallurgy of Pu metal, 17: 16553
KIRKPATRICK, Alan Robert, Nuclear reactors, 17: 17518
KIRS, J., Luminescence of phosphors activated with Eu, 17: 16862
KIRSHENBAUM, A. D., Preparation and some properties of KrF_4, 17: 16021
KISHIKAWA, Yasushi, Blood picture and bone marrow in A-bombed survivors, 17: 15828
KISLYAK, G. M., Phosphorescence of boronphthalic phosphors, 17: 16089
KISLYAK, G. M., Phosphorescence of phthalic acid in alums, 17: 16090
KITABATAKE, T., Spermatogenesis of rats injected with Cs-137, 17: 15704

KIVELSON, Margaret G., Propagation of EM waves in plasmas, 17: 17373
KLAND-ENGLISH, Mathilde, Radiolysis of solid peptides, 17: 16071
KLATZO, Igor, Effects of α particle radiation on rat brain, 17: 15695
KLEIN, A., Theory of normal Fermion systems, 17: 17078
KLEIN, Deane T., Interaction of ionizing and visible radiation in mutation induction in *Neurospora crassa*, 17: 15652
KLEIN, Oskar, Matter-antimatter annihilation and cosmology, 17: 16911
KLEIN, Richard M., Interaction of ionizing and visible radiation in mutation induction in *Neurospora crassa*, 17: 15652
KLEIN, Siegfried, Interpretation of energy conversion phenomenon, 17: 17346
KLESSMANN, H., Transistor decade counter, 17: 16390
KLIMONTOVICH, Yu. L., Isotropic turbulence in relativistic plasma, 17: 17348
KLING, Harry P., Concentric-cylindrical reactor fuel element, 17: 17519
KLING, S., Homografts in dog after lethal irradiation, 17: 15814
KLUEVER, Johan W., Cyclotron wave parametric amplifier, 17: 16406
KLUMB, R. H., Boron stainless steel control rods for Pathfinder, 17: 17531 (ACNP-63001)
KLYUCHAREV, A. P., Isomeric transitions in even-even nuclei with half life 10^{-6} to 10^{-1} sec, 17: 17147
KNAPP, V., Equality of velocity of γ rays in transverse magnetic field, 17: 16974
KNAUER, W., Radial field distribution in Penning discharge, 17: 16804
KNELLER, E., Gd_2Bi_3—new ferromagnetic compound, 17: 16670
KNEPPEL, D. S., Cracking of oxide films on Zr in steam, 17: 16590 (NMI-1254(p.3-43))
KNIGHT, James A., Jr., Prog. rpt. on cyanogenation of organic compounds, 5/60–2/63, 17: 16042 (SRO-78)
KNIGHTS, Herbert Chilvers, Improvements in nuclear reactors, 17: 17487
KNIPLING, E. F., Radiation sterility in insect problems, 17: 15559
KNOP, G., Scattering of 8-Bev μ mesons on electrons, 17: 17017
KNOWLES, Alan K., Radiation warning device, 17: 16478
KNOX, John M., Carcinogenic effect of exposure to grenz ray, 17: 15823
KNUTSON, Charles Dwaine, NMR studies of neutron-irradiated fluorides, 17: 16111
KO, R., Ion exchange-spectrographic determination of Th in U ores, 17: 15898
KOBAYSHI, Yoshikazu, Properties of Fe–Be compounds, 17: 16704
KOBLE, Robert A., Carbonate leaching of U-bearing ores, 17: 16135
KOBLE, Robert A., Fractional precipitation of U, 17: 16133
KOCH, Charles W., Reaction of XeF, with aqueous solutions, 17: 16020
KOCHERGIN, V. P., One-group theory in nuclear reactor calculations, 17: 17461
KOCHERZHINSKII, Yu. A., Chromium–Nb–Ti alloys, 17: 16543
KOCHUBEI, N. P., Spherical harmonics in transport theory. P_3 approximation, 17: 17457
KOCHUBEI, S. M., Spectrum of monodeuterobenzene, 17: 16010
KODAMA, Masahiro, Measurements of slow neutrons in Pacific and Indian Oceans, 17: 16933
KOECHLIN, F., Behavior of plasma produced by button-type source, 17: 17360
KOECHLIN, Yves, Short luminous pulses and application to scintillation phenomena, 17: 16421 (CEA-2194)
KOECKER, K. H., Reactor for energy requirements of electric propulsion, 17: 17608
KOEHLER, W., Spectral distribution of neutrons in core and reflector of pool-type reactors, 17: 17600 (CEA-tr-A-1194)
KOERNER, Harry E., Therapy unit, 17: 16221
KOERTS, L. A. Ch., Dissociation of deuterons, 17: 17185
KOGA, Toyoki, Reply to comments of Pieter Schram, 17: 17368
KOHLER, D., Alpha spectra from d reactions on Li-7, 17: 17223
KOKALAS, J. J., Reflectance spectra of metallic oxides, 17: 15970
KOLAR, Jaromir, Calcium metabolism in epi- and metaphysis after local x irradiation. V., 17: 15755
KOLAR, R. D., Prog. rpt. on measurement of capture γ rays from elements, 11/62–1/63, 17: 15943 (ARF-1193-20)
KOLBER, Stanislaw, Automatic steering of neutron spectrometer; 17: 16454
KOLCHIN, A. M., Superconducting Nb–Zr alloy at 9250 Mc/s, 17: 16722
KOLESNIKOV, N. N., Beta stability of heavy elements, 17: 17148
KOLESOV, V. E., Calculations of transport cross sections, 17: 17472
KOLOMENSKII, A. A., Resonance phenomena in motion of particle in plane wave, 17: 17052
KOLOMIITSEVA, I. K., Free radicals in rat liver lipids after γ irradiation, 17: 15672
KOLOUSEK, Jaroslav, Influence of x-irradiation on K-42 content in rats, 17: 15687
KOLOUSEK, Jaroslav, Influence of radiation on nucleic acids, vitality, and fecundating ability of male sexual cells, 17: 15689
KOLYBASOV, V. M., Mechanism of π^--meson capture by light nuclei, 17: 17273
KOMAROV, V. V., Mechanism of the $C^{12}(p,p'3\alpha)$ reactions, 17: 17174
KOMISSAROVA, L. N., Model for extraction of Hf and Zr with TBP, 17: 16165
KOMISSAROVA, L. N., Optimum conditions in extraction of Hf with TBP, 17: 16166
KOMKOV, A. I., Euxenite and priorite—varieties of $YNbTiO_6$, 17: 15982
KOMPANEETS (KOMPANEYETS), A[leksandr] S[olomonovich], Theoretical physics, 17: 17401
KOM'SHIN, V. A., Energy and angular distributions of γ quanta passing through finite thickness, 17: 17466
KONDO, Michiya, Angular distributions of (α,n) reactions on Be and C, 17: 17154
KONIJN, J., Computations for circular radiator and circular detector, 17: 16943 (AE-101)
KONOBEEVSKII, S. T., Radiation effects on materials, 17: 16763
KONSTANTINOV, I. O., Neutron polarization in $C^{13}(d,n)N^{13}$ reaction, 17: 17264
KONSTANTINOV, V. I., Electrolytic production of Ta and Nb and their alloys, 17: 16547
KOPYLOV, G. I., Forbidden meson configurations in multimeson decay, 17: 16952 (JINR-P-1161)
KORCHEMKIN, V. I., Responses to adrenaline in dogs recovering from radiation sickness, 17: 15840
KORDA, Yu. S., Isomeric transitions in even-even nuclei with half life 10^{-6} to 10^{-1} sec, 17: 17147
KORENEV, Yu. M., Rhombic modification of BeF_2, 17: 16673
KORENMAN, G. Ya., Angular distribution and polarization of recoil nuclei in capture of partially polarized μ^- mesons, 17: 17117 (JINR-P-1160)
KORITSKII, A. T., Formation of diaryl nitrogen oxide radicals, 17: 16064
KORNBICHLER, Heinz, Device for pressure suppression vapor containment, 17: 17514
KORNEVA, E. I., Radiation effects on morphological changes in plants, 17: 15749
KORNILOV, I. I., Strength of Ti alloy based on Ti_3Al, 17: 16677
KOROGODIN, V. I., Influence of post-irradiation conditions on effects on yeast cells, 17: 15739
KOROTKOV, K. A., Internal bremsstrahlung β decay of Ca-45, 17: 17260
KOROTKOVA, V. P., Prophylaxis of radiation damage in animals, 17: 15841
KOROTKOWA, W. P., Peculiarities of radiation injuries and protection of intact and sympathectomized animals, 17: 15844
KOROVIN, Yu. I., Determination of admixtures in alkaline metals, 17: 15923
KOSKELIN, M., 992 Kev $Al^{27}(p,\gamma)Si^{28}$ resonance, 17: 17200
KOTLYAR, B. I., Effect of additions of oxides on Mg–Mn ferrites, 17: 16019
KOTOV, A. G., Radicals in γ irradiation of solid ammonia and hydrazine, 17: 16093
KOTOV, Yu. I., Spectra of liquid deuterated hydrazine N_2D_4, 17: 16009
KOULKES-PUJO, Anne-Marie, Formation and decomposition of H_2O_2 by γ and α rays, 17: 16058 (AEC-tr-5687)
KOVALENKO, V. A., Photoproduction amplitude from dispersion relations, 17: 17274
KOVANIC, Pavel, Automatically starting reactor from subcriticality, 17: 17517
KOVTUNOVICH, L. G., Antibody formation process during irradiation, 17: 15647 (JPRS-18020)
KOYAMA, Shin, Effect of radiation on protein metabolism, 17: 15750
KOZAK, O. V., Escape of charged particles from plasma, 17: 17379
KOZHEMYAKIN, V. A., Chlorination of loparite concentrate, 17: 16024
KRAAK, W., Transplutonium elements. II., 17: 15972
KRAITZER, Ian C., Extraction of thoria and ceria from rare earth ores,

17: 16130
KREBS, Johannes, Welded structural elements of nuclear power plant, 17: 17583
KRESTOVNIKOV, A. N., Preparation of Ta and Nb by reduction of pentachlorides, 17: 16548
KRICK, W., Abdominal fusiform sarcoma after thorotrast, 17: 15711
KRIEVE, W. F., Fission-fragment conversion reactors for space, 17: 16189
KRIVKO, N. I., Superconducting Nb–Zr alloy at 9250 Mc/s, 17: 16722
KROHMER, Jack S., Radioisotope scanning for pericardial effusions, 17: 15582
KROLIKOWSKI, W., Unitary symmetry and leptonic hyperon decays, 17: 16963
KROLL, Harry, Prog. rpt. on chelating agents for urinary excretion of Sr, 12/61–12/62, 17: 15589 (TID-18058)
KRUGER, O. L., Preparation and properties of arc-cast PuC, 17: 16688
KRUMHOLZ, Paweł, Separating yttrium and rare earths, 17: 16168
KRYLOVA, A. P., Beta stability of heavy elements, 17: 17148
KRZHIVANEK, M., Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
KRZHIVANEK, M., Formation of $Zr^{97}Cl_4$ by slowing down of fission fragments, 17: 16065
KUBOTA, Hisashi, Ionic analyses, 17: 15861 (ORNL-3397(p.117-21))
KUCHIN, V. D., Induced emf and dielectric strength in x-irradiated PVC, 17: 16761
KUEMMEL, H., Expansion of Fermi gas wave function, 17: 17077
KUENDIG, Walter, Transverse Doppler effect in an accelerated system, 17: 17208
KUENLEN, H., Nine years of supervolt therapy, 17: 15576
KUERZ, G., Reactor for energy requirements of electric propulsion, 17: 17608
KULKA, Milan, Automatically starting reactor from subcriticality, 17: 17517
KULP, B. A., Electron radiation damage in ZnSe, 17: 16757
KULP, Bernard A., Electron processing of semiconducting material, 17: 16581
KULYUKIN, M. M., Probabilities of $\mu^- + He^3 \rightarrow H^3 + \nu$ reaction, 17: 17278
KUMAHARA, Yuichi, Estimating hepatic clearance with use of I^{131}-rose bengal and colloidal Au-198, 17: 15611
KUND, G. G., Spectrometric determination of Pb-204, 17: 15905
KUNZ, H. R., Prog. rpt. on heat rejection in space power plants, 9–11/62, 17: 16230 (PWA-2132)
KURAOKA, Seizo, Blood picture and bone marrow in A-bombed survivors, 17: 15828
KURIHARA, Yozo, Characteristics of several refractory metals, 17: 16712
KURIMURA, Yoshimi, Radiation-induced oxidation in Sb(III)–Fe(II) solution. I., 17: 16080
KURNICK, S. W., Prog. rpt. on radiation effects on Si solar cells, 12/61–12/62, 17: 16736 (GA-3872)
KUROSAWA, Ryuthei, Activation analysis of metal, 17: 15919
KURSUNOGLU, Behram, Brownian motion and "resonance diffusion" in magnetic field, 17: 17340 (TID-18115)
KURZWEG, Frank T., Single dose x irradiation of lung and posterior mediastinum. III., 17: 15830
KUSHWAHA, R. S., Astrophysical application of 7.20(4+)–Mev state of Ne-20, 17: 16916
KUSHWAHA, R. S., Virial theorem for plasmas, 17: 17372
KUSTAS, V. L., Spectrographic determination of admixtures in high-purity La oxide, 17: 15932
KUTATELADZE, S. S., Heat transfer in turbulent flow, I and II, 17: 16236 (AERE-Trans-911(Pts.1 & 2))
KUTTIG, Helmut, Protection of eye in telecobalt therapy, 17: 15756
KUZIN, A. M., Free radicals in rat liver lipids after γ irradiation, 17: 15672
KUZMA, Witold, Construction of BF, proportional counters, 17: 16455
KUZNETSOVA, L. I., One-group theory in nuclear reactor calculations, 17: 17461
KUZNETSOVA, R. I., Formation mechanism of light nuclei, 17: 17149
KVERNES, Ingard, Prog. rpt. on mechanical properties of Nb, 7–9/62, 17: 16652 (NP-12633)
KVERNES, Ingard, Prog. rpt. on mechanical properties of Nb, 1–3/62, 17: 16653 (NP-12634)
KWUN, Sook-il, Prog. rpt. on liquid coolants, 1/28/61–1/31/62, 17: 16031 (TID-17275)

L

LABARCA, C., Wetting agents in foliar nutrition, 17: 15557
LA BARRE, Douil, Nuclear reactor control, 17: 17589
LACHAUD, R., Water content of thin samples by neutron diffusion, 17: 15902
LACOSTE, F., Scattering of 150-Mev electrons by O-18, 17: 17120 (LAL-1029)
LACOUR, Jean, Nuclear reactor control, 17: 17589
LADY, Edward R., Prog. rpt. on low heat flux boiling, 10/61–1/62, 17: 16231 (TID-15719)
LADYZHENSKII, M. D., MHD hypersonic flow over a wedge, 17: 16855
LAGACHE, M. P., Prog. rpt. on Pu recycle, 7–9/62, 17: 16738 (GEAP-4081)
LA GRANGE, L. D., Electrical resistivity of stabilized zirconia, 17: 16683
LAGUN, M. A., Role of thyroid gland in radiation sickness, 17: 15673
LAGUTINA, N. Ya., Blood coagulating system in irradiated animals, 17: 15837
LAHAIE, G., Strontium, Ba and Ca in human diet, 17: 15587 (CRER-1068)
LAING, T. F., Diffusion of fission products from graphite, 17: 16690
LAJTAI, A., Angular distribution of γ rays from fission of U-235, 17: 17203
LAJTHA, L. G., Recovery of *Vicia faba* roots from radiation, 17: 15728
LAMM, C. G., Isotopic exchange in soil fertility studies, 17: 15581
LAMPE, D. A., Instrumentation for fuel column, EGCR, 17: 17553 (TID-18102)
LAMPE, D. A., Pneumatic temperature monitoring system for EGCR, 17: 17561 (TID-18240)
LANDSVERK, Ole G., Gas-filled dosimeter, 17: 16480
LANG, F. M., Oxidation in air and CO_2 of various purified graphites, 17: 15966 (NP-tr-958)
LANGE, W. J., Prog. rpt. on vacuum techniques, annual, 1962, 17: 16181 (TID-18283)
LANGENDORFF, H., Mechanism of radiation protection substances in mammals, 17: 15827
LANGER, S., Prog. rpt. on carbide cathode studies, final, 1/30/63, 17: 16774 (GA-3642)
LANGLEY, R. A., Atomic collisions in space phenomena, 17: 16886
LANGMEAD, W. A., Personnel dosimetry in presence of soft radiation, 17: 16433
LANGSFORD, A., Scattering of neutrons by U from 18 to 120 Mev, 17: 17159
LAQUER, Henry L., Electrical flux pump for powering superconducting magnet coils, 17: 16174 (LADC-5418)
LARICHEV, A. V., Continuous spectra of fast neutrons and γ quanta, 17: 16438
LARSH, John E., Jr., Histopathologic study of immunized mice exposed to total-body x irradiation, 17: 15654
LARSON, Allen C., Crystal structure of Pu_2Co, 17: 16647 (LADC-5363)
LARSON, Allen C., Solid solubility in metallic alloys, 17: 16518 (LADC-5380)
LASER, H. W., X irradiation of glucose oxidase and riboflavin, 17: 15774
LASH, L. D., Recovery of Sc from U solutions, 17: 16164
LATTER, Richard, Ionization effects from nuclear explosions in space, 17: 16292
LATTERELL, Richard L., Sensitivity of maize chromosomes to x rays, 17: 15650
LATYSHEV, V. I., Chromium–Nb–Ti alloys, 17: 16543
LAUGIER, J., Order-disorder transition in Fe–Ni, 17: 16701
LAURITA, W., Prog. rpt. on thermionic emitter, 8/15/62–2/15/63, 17: 16773 (EDR-3207)
LA VALLE, D. E., Inorganic preparations, 17: 15859 (ORNL-3397(p.112-13))
LAVIE, J. M., Rules for safety from contamination, 17: 16333 (AEC-tr-5690)
LAVRUKHINA, A. K., Formation mechanism of light nuclei, 17: 17149
LAWRENCE, John H., Treatment of chronic lymphocytic leukemia, 17: 15697
LAWROSKI, Stephen, Reactor Fuel Processing, Vol. 6, No. 1, 17: 17449
LAWSON, E. M., Angular distribution of photoproduction of positive pions from H by γ rays, 17: 16985
LAZARD, Bertrand, Isotopic exchange in presence of non-volatile catalyst, 17: 16497

LAZEBNAYA, G. V., Spectrographic determination of admixtures in high-purity La oxide, 17: 15932
LAZURKII, Yu. S., Radicals in proteins during irradiation, 17: 15766
LEA, K. R., Raising of angular momentum degeneracy of f-electron terms, 17: 15940 (AFCRL-62-929)
LEACH, Richard F., Propagation of signals through space, 17: 16890
LEANG, Chin-Fan, Alpha energies of Pu-238, Pu-239, Pu-240, and Am-241, 17: 17143
LEASK, M. J. M., Raising of angular momentum degeneracy of f-electron terms, 17: 15940 (AFCRL-62-929)
LE BAUD, Pierre Marie, Nuclear reactor control, 17: 17589
LEBEDEV, A. N., Resonance phenomena in motion of particle in plane wave, 17: 17052
LEBEDEV, K. A., Bone marrow chimeras of guinea pigs, 17: 15839
LEBRUN, P., Treatment station for solid radioactive waste, 17: 17614 (CEA-2195)
LECHNICK, W., Reactor coolant radionuclide base levels. PWR Core 1, Seed 3, 17: 17573 (WAPD-PWR-TE-128(Rev.))
LECHNICK, W., Tritium concentration in PWR using Li-7 resin, 17: 17572 (WAPD-PWR-TE-103)
LE CLERC, Pierre G., Apparatus for measurement of flux of neutrons, 17: 16477
LEDOUX, L., Effect of x rays on germinating barley, 17: 15775
LEE, J. A., Physical properties of Pu studied at Harwell, 17: 16563
LEE-WHITING, G. E., Focusing of charged particles in magnetic field, 17: 16387
LEFFINGWELL, Thomas P., Protection against ionizing radiation, 17: 15633 (SAM-TDR-62-103)
LE FOLL, Jean, Thermal exchange of fuel elements in reactors, 17: 17502
LEFRANCOIS, Bernard, Preparing amides of K, Rb, or Cs, 17: 15870
LEGAR, F., Conformal mapping in scattering of high-energy particles, 17: 17054
LEHMANN, H., Ceramic materials containing rare earths, 17: 17434
LEHRNBECHER, W., Reduction of absorption of radioactive material by means of astringents, 17: 15553
LEIBOWITZ, Jack Richard, Ultrasonic shear wave attenuation in superconducting Sn, 17: 16729
LEINHOS, Eberhard, Welded structural elements of nuclear power plant, 17: 17583
LEININGER, Robert I., Radiolysis of the isomeric poly(butyl methacrylates), 17: 16070
LEITH, D. W. G. S., Angular distribution of photoproduction of positive pions from H by γ rays, 17: 16985
LEITZ, F. J., Prog. rpt. on fast ceramic reactor, 7/59–9/61, 17: 17409 (GEAP-3811)
LE LEVIER, Robert E., Ionization effects from nuclear explosions in space, 17: 16292
LEMEILLE, C., Alpha particles from reaction Li-6 + Li-7, 17: 17197
LEMKE, B. J., SAIL—NAA program description, 17: 17093 (TID-18117)
LEMKE, Barbara, FORTRAN SNG code, 17: 16507 (TID-18116)
LEMONNE, J., Interactions of K^- mesons with nuclei, 17: 17191
LEONARD, A., Criticality problem for spheres and slabs, 17: 17425 (RM-3256-PR)
LEONG, G. F., Effects of divided doses of x ray on mortality and hematology, 17: 15804 (USNRDL-TR-606)
LEONOV, B. V., Effects of γ radiation on Hep-2 culture, 17: 15738
LEPEKHIN, F. G., Angular correlations in stars with fragments produced by 9-Bev protons, 17: 17262
LEPOUTRE, Gerard, Preparing amides of K, Rb, or Cs, 17: 15870
LERAT, Jean-Marie, Isotopic exchange in presence of non-volatile catalyst, 17: 16497
LERMAN, Sidney, Radiation cataractogenesis, 17: 15717
LEROY, Rene, Ball and socket joints for remote controls, 17: 16219
LESHCHINSKII, N. I., Transportation of radioactive materials, 17: 16354
LESHUK, A. I., Inelastic neutron scattering on Fe, 17: 17473
LE STOURGEON, W. L., Breeding characteristics of offspring from irradiated sires, 17: 15629 (LADC-5278)
LE STOURGEON, W. L., Radioresistance in offspring from irradiated parentage, 17: 15630 (LADC-5401)
LEUSEN, I., Total irradiation with x rays and adrenal activity, 17: 15808
LEVIN, F. L., Change in cell resistance to uv rays, 17: 15674
LEVINE, Charles Arthur, Preparation of graft polymers, 17: 16112
LEVY, Bernet M., Experimental berylliosis. I., 17: 15598
LEVY, Henri A., Xenon tetrafluoride molecule and its thermal motion, 17: 16023
LEWIS, C. T., Observations of 5577A emission from aurora, 10/61, 17: 16302
LEWIS, G. M., Angular distribution of photoproduction of positive pions from H by γ rays, 17: 16985
LEWIS, Gerald Philip, Isotope effect on H electrodes, 17: 16493
LEWIS, J., Exchange of Cl-36 of Group III chlorides with nitrosyl and phosphoryl chlorides, 17: 15996
LEWIS, L., DYNAPAK extrusion of I & E fuel elements, 17: 16604 (BRB-69)
LI, Angelo C., Lifetimes of 4+ and 2+ states in rotational nuclei, 17: 17219
LI, H. W., Utilization of x-ray radiation for rice, 17: 15564
Li, Lan-hsiang, Spectrophotometric determination of Th, 17: 15910
LIANG, Shu-ch'uan, Separation and determination of Th and Sc, 17: 15909
LIBKE, K. G., Prog. rpt. on effects of irradiated diet, 9/15/62, 17: 16363 (NP-12600)
LIBOFF, R. L., Gravitational instability, 17: 16831
LIEMOHN, H. B., Dispersion function for a plasma, 17: 17357
LIETZKE, Marjorie P., Algol 60 syntax checker for computer, 17: 16505 (ORNL-3399)
LIGETI, Gyoergy, Characteristic qualities of atomic power stations, 17: 17576
LIKHTMAN, V. I., Action of electron and γ radiation on Zn crystals, 17: 16676
LIKHTMAN, V. I., Effect of β irradiation and surface-active agent on Zn, 17: 16749
LILIENFELD, P., Prog. rpt. on stratospheric monitoring, 12/60–1/61, 17: 16319 (NYO-9674)
LILJEBLAD, Ragnar, Gas cooled reactor, 17: 17501
LILLEHEI, Richard C., Suspensions of spleen and bone marrow for treatment of supralethally irradiated dogs, 17: 15845
LILLEY, J. S., Polarization in proton–C scattering at 28 Mev, 17: 17198
LILLIE, A. F., Effect of gas content on ONB point for Santowax OM + 30 w/o HB, 17: 16228 (NAA-SR-Memo-8064)
LINCOLN, J. Virginia, Improving forecasts of geomagnetic storms, 17: 16290
LINDGREN, J., Prog. rpt. on carbides for thermionic space reactors, 11/30/62, 17: 16516 (GA-3866)
LINDNER, R., Adsorption of radioactive rare earths, 17: 16149 (CEA-tr-A-1230)
LINDSAY, John C., Solar radiation monitoring, 17: 16471
LINDSTROEM, Boerje, Precision determination of γ energies, 17: 17165
LINDTVEIT, Torleif, Prog. rpt. on mechanical properties of Nb, 7–9/62, 17: 16652 (NP-12633)
LINDTVEIT, Torleif, Prog. rpt. on mechanical properties of Nb, 1–3/62, 17: 16653 (NP-12634)
LINEBERGER, W. C., Prog. rpt. on ionization of alkali ion, 12/62–2/63, 17: 16792 (TID-18258)
LINHARDT, Hans D., Solar-electric-thermal propulsion methods, 17: 16196
LIPPMANN, M., Prog. rpt. on stratospheric monitoring, 2/61–4/62, 17: 16320 (NYO-9675)
LIPSKY, S., Radiation chemistry of organic liquid mixtures, 17: 15768
LISENKO, G. M., Phosphorescence of boronphthalic phosphors, 17: 16089
LISENKO, G. M., Phosphorescence of phthalic acid in alums, 17: 16090
LITTLE, R., Angular distribution of photoproduction of positive pions from H by γ rays, 17: 16985
LIU, Cheng-lieh, Radioisotopes in study of wear due to friction, 17: 16377
LOCHTE, H. L., Jr., Infusion of marrow in the mouse and dog after thio-TEPA, 17: 15548
LOCK, W. O., Fission of U, Th, and Bi by 20-Bev protons, 17: 17180
LOCKEY, David John, Improvements in monitors for α particles, 17: 16476
LOCKWOOD, J. A., Asymmetries in Forbush decreases. I., 17: 16925
LOCKWOOD, J. A., Asymmetries in Forbush decreases. II., 17: 16926
LOCKWOOD, P. A., Prog. rpt. on radioactive fuel-bearing glasses, 4/61–3/62, 17: 16525 (NYO-9736)
LOEW, G. A., Design of Stanford two-mile accelerator, 17: 17316 (SLAC-7)
LOGSDAIL, D. H., Renoval of I vapor from air with Cu, 17: 16008
LOKEN, J. G., Proton-antiproton cross sections, 17: 17006
LOMBARDI, L., Renal lesions from ionizing radiation. I., 17: 15712

LOMBARDI, L., Renal lesions from ionizing radiation. II., 17: 15713
LOMER, W. M., Transition metal alloys, 17: 16697
LONG, Arthur, X-ray beam spectrometer, 17: 16485
LONG, R. A., Prog. rpt. on brazing of refractory alloys, 11/62–1/63, 17: 16608 (NP-12615)
LONGERBEAM, Jerrold K., Suspensions of spleen and bone marrow for treatment of supralethally irradiated dogs, 17: 15845
LONGLEY, H. J., Temperature rises in radioactive wastes, 17: 17617 (LADC-5366)
LONGOSTREVI, G. Poggi, Renal lesions from ionizing radiation. I., 17: 15712
LONGOSTREVI, G. Poggi, Renal lesions from ionizing radiation. II., 17: 15713
LONNEY, F. D., Decay of irradiation defects in polymethyl methacrylate, 17: 16060
LORENTZ, R. A., Release of fission products on in-pile melting of fuels, 17: 16325 (ORNL-3401(p.35-9))
LOSKIEWICZ, J., Analysis of spectrum of ionization pulses caused by nuclear active particles, 17: 16919
LOUNASMAA, O. V., Specific heat of Gd and Yb between 0.4 and 4°K, 17: 16015
LOUTHAN, M. R., Jr., Hydride orientation control in Zy-2, 17: 15958 (TID-16476)
LOUTHAN, M. R., Jr., Metallographic preparation of Zy-2, 17: 16656 (TID-16475)
LOW, W., Spectrum of GD in $LaAlO_3$, 17: 16016
LUBCKE, Harry R., Radioactivity detector, 17: 16483
LUBLOW, D., Effective cross sections for bremsstrahlung and pair production, 17: 17105 (DESY-A-2.96)
LUCE, J. S., Prog. rpt. on electrodeless pulse plasma propulsion, final, 7/61–11/62, 17: 16771 (ASD-TDR-62-1105)
LUKOVNIKOV, A. F., Formation of diaryl nitrogen oxide radicals, 17: 16064
LUKYANOV, A. A., Effects of scattering on resonance absorption of neutrons, 17: 17468
LUK'YANOV, V. P., Determination of absorbed x-ray doses in animals, 17: 16350
LUND, L., Fallout in Norwegian milk in 1961, 17: 15614 (A/AC.82/G/L.810)
LUNDIN, Charles E., Prog. rpt. on Nb-rich region of ternary phase diagrams, 12/62–3/63, 17: 16641 (DRI-2091)
LUO, H. L., Binary alloys of rare earth metals with Au and Ag, 17: 16658 (TID-18197)
LUSE, D., Burst slug detection system for EGCR, 17: 17530 (ACNP-62509)
LUSE, D., Burst slug detection equipment shield analysis for EGCR, 17: 17562 (TID-18241)
LUSE, D., Burst slug detection system for EGCR, 17: 17563 (TID-18242)
LUSHCHIK, N., Sensitized luminescence of $Ca_3(PO_4)_2$–Ga, Mn, and $Ca_3(PO_4)_2$–In, Mn, 17: 16088
LUTZ, M. A., Radial field distribution in Penning discharge, 17: 16804
LUX, Franz, Activation determination of Ag in materials containing Cd. I., 17: 15912
LYERLY, R. L., Prog. rpt. on hydraulic ball control system, 10–12/62, 17: 17412 (GNEC-264)
LYKOUDIS, P. S., Skin friction for turbulent magnetofluidmechanic channel flow, 17: 16229 (NP-12631)
LYON, T. F., Prog. rpt. on plastics and refractories, 1–3/62, 17: 16632 (AD-274654)
LYON, W. S., Internal conversion coefficients in the decay of Au-199, 17: 17238
LYON, W. S., Nuclear and radiochemical analyses, 17: 15858 (ORNL-3397(p.71-112))
LYONS, L., Deuteron-deuteron scattering at 20 to 70 Mev, 17: 17010
LYONS, L., Proton-deuteron interactions at 77 Mev, 17: 17009
LYS, J. E. A., Deuteron-deuteron scattering at 20 to 70 Mev, 17: 17010
LYSIKOV, Yu. A., Internal bremsstrahlung β decay of Ca-45, 17: 17260
LYUBIMOV, V. B., γ Production in interaction of π^- mesons with nuclei, 17: 17192
LYUBIMOV, V. B., Radiative decays of resonance states, 17: 17119 (JINR-P-1164)

M

MAC DONALD, R. D., Irradiation of Zy-2 clad UO_2, 17: 16735 (EXP-NRX-2807)
MACHNIG, Herbert, Safety device for nuclear reactors, 17: 17511
MACHTA, Lester, Detection of debris from atmospheric tests, 17: 16902
MAC KAY, Colin, Reaction mechanisms of recoil C atoms, 17: 16078
MAC KINNEY, A. L., Pile oscillator experiments with ATRCE, 17: 16942 (TID-18064)
MAC KINNEY, A. L., Temperature coefficients in ATRCE Core, 17: 17599 (TID-18254)
MACKLIN, R. L., Capture cross sections for 30- and 65-kev neutrons, 17: 17222
MADANSKI, L., Measuring polarization of positrons, 17: 17004
MAEDA, Toshio, Deoxyribonucleoprotein of mouse spleen irradiated with γ rays, 17: 15706
MAERKL, H., Physics of D_2O lattices, 17: 17402 (AECL-1684)
MAGDA, T., Angular distribution of polarized neutrons from $Li^7(p,n)Be^7$, 17: 17167
MAGINU, Naoko, Carbon-14 in a biological environment. I., 17: 15618
MAGNUSON, G. D., Electron ejection from metals. I., 17: 16836
MAGNUSON, G. D., Electron ejection from metals. II., 17: 16837
MAHANTHAPPA, Kalyana, Baryon mass splitting and weak and strong couplings, 17: 17016
MAIER, B. P., Construction of bent-crystal γ spectrometer, 17: 16447
MAIER, B. P., Equipment of bent-crystal γ spectrometer, 17: 16448
MAIRHOFER, H., Determination of flow of ground water in bore hole using, 17: 16268
MAKAROV, E. F., Quadrupole splitting in Mössbauer spectra, 17: 16013
MAKAROV, E. S., Crystal structure of umohoite, 17: 15984
MAKAROV, M. M., Angular correlations in stars with fragments produced by 9-Bev protons, 17: 17262
MAKAROVA, V. P., Determination of Th in presence of rare earths, 17: 15926
MAKHON'KO, K. P., Spectrum of the size distribution of natural radioactive aerosols, 17: 16279
MALAISE, Edmond, Radiosensitivity of tumor predecessor, 17: 15671
MALAMUD, E., Positron-electron annihilation in flight, 17: 16986
MALCOLM, Daniel, Association of radioactive Cr with various components of hemoglobin, 17: 15593
MALET, Georges, Analysis of fission products by γ spectrography, 17: 15874 (CEA-2226)
MALHOTRA, Om P., Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16364 (NP-12602)
MALKOWSKI, G., Definite detection of radioactive precipitations, 17: 16267
MALY, Ya., Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
MAMURO, T., Fractionation in fallout particles, 17: 16344
MANDEL, L., Symposium on photo-electronic image devices, London, 9/61, 17: 16394
MANNING, D. L., Analysis of molten salts, 17: 15853 (ORNL-3397(p.24-6))
MANNO, Peter Joseph, Polymerization of vinyl fluoride, 17: 16113
MANSFIELD, Roger G., Formation and decomposition of H_2O_2 by γ and α rays, 17: 16058 (AEC-tr-5687)
MAOR, Dalia, Increased RNAse activity in lymphatic cells following irradiation, 17: 15690
MARCHUK, G. I., One-group theory in nuclear reactor calculations, 17: 17461
MARCHUK, G. I., Resonance capture of neutrons in annular trap, 17: 17469
MARCHUK, G. I., Spherical harmonics in transport theory. P_n approximation, 17: 17456
MARCHUK, G. I., Spherical harmonics in transport theory. P_3 approximation, 17: 17457
MARCHUK, G. I., Theory and calculations of nuclear reactors, 17: 17455
MARDON, P. G., Physical properties of Pu studied at Harwell, 17: 16563
MARESCA, M. W., Heat transfer to Hg flowing in-line through bundle of circular rods, 17: 16222 (BNL-6826)
MARIN, P. C., Scattering of 8-Bev μ mesons on electrons, 17: 17017
MARKHAM, Jordan J., Prog. rpt. on magnetic properties of insulators, 11/16/62–2/15/63, 17: 15942 (ARF-1184-8)
MARKLUND, Ingvar, Precision determination of γ energies, 17: 17165
MARKOV, M. A., Method of regularization in field theory, 17: 16825

MARKOV, M. A., Theory of weak interactions, 17: 16975
MARKUS, G., Reusable-manned-nuclear orbital carrier, 17: 17613
MARQUEZ, L., Alpha particles from reaction Li-6 + Li-7, 17: 17197
MARQUISEE, J., Apparatus for study of primary processes in radiation chemistry, 17: 16044 (TID-18144)
MARRAM, Edward P., Infrared spectra of alkali metaborate vapors, 17: 15945 (AROD-006.8)
MARSHALL, R. P., Hydride orientation control in Zy-2, 17: 15958 (TID-16476)
MARSHALL, Thomas, Recombining atomic N with plasmas, 17: 16888
MARTALOGU, N., Angular distribution of polarized neutrons from $Li^7(p,n)Be^7$, 17: 17167
MARTELLUCCI, S., Schlieren photography of an orthogonal pinch, 17: 17355
MARTENS, Hans, Producing reactor grade U, 17: 16124
MARTIN, D. W., Atomic collisions in space phenomena, 17: 16886
MARTIN, Dudley C., Radiation effects on broccoli, sweet corn, and strawberries, 17: 15675
MARTIN, J. L., Covariant quantum field theories with indefinite metric, 17: 16856
MARTIN, J. P., Proton radiation dosage in vehicle in trapped belt, 17: 16876
MARTIN, R. Bruce, Deuterated water effects on acid ionization constants, 17: 16022
MARTIN, W. M., New isomers in Sb and I, 17: 17141
MARTINSON, R. H., Creep deformation of stoichiometric UO_2, 17: 16687
MARTIUS, Heinrich, Radiation tolerance dose of ovaries, 17: 15594
MARTTINEN, Eino, Reactivation of erythropoiesis by Co after radiation injury, 17: 15810
MARTYNENKO, Yu. V., Scattering of slow electrons on atoms, 17: 17269
MARYANOV, B. M., Determination of Nd by radiometric titration, 17: 15925
MASKREY, J. T., Arc initiation on heated Mo exposed to toroidal H discharge, 17: 16538
MASON, R., Physical mechanisms in enzyme inactivation, 17: 15780
MASSA, D., Determination of isodose curve in a Co-60 source, 17: 15578
MASSALSKI, J., Analysis of spectrum of ionization pulses caused by nuclear active particles, 17: 16919
MASUDA, Akimasa, Discrepancy in age determination with Pb isotopes, 17: 16301
MATHUR, P. B., Irradiation of fruits and vegetables in India, 17: 16375
MATOVICH, S., Vessel, core and control rod alignment of EGCR, 17: 17570 (TID-18250)
MATRICON, J., Nature of driving force in flux creep phenomena, 17: 16805
MATSCHINER, J. T., Prog. rpt. on wholesomeness of irradiated food, 7/15/61–9/1/62, 17: 16360 (NP-12597)
MATSUMOTO, Shigeo, Nucleon–nucleon interactions 100 Bev, 17: 16971
MATSUNAMI, T., Fractionation in fallout particles, 17: 16344
MATSUO, T., Radiation-induced mutations in crop breeding, 17: 15566
MATSUOKA, Osamu, Effect of x irradiation in intestines of animals, 17: 15705
MATSUURA, Niro, Radiation-induced oxidation in Sb(III)–Fe(II) solution. I., 17: 16080
MATSUYAMA, Akira, Effects of alkali halides on radiation inactivation of taka-amylase in aqueous system, 17: 15592
MATTHIAE, G., Negative pion absorption in complex nuclei, 17: 17108 (ISS-62/21)
MATTHIAE, G., Particle loss due to scattering in counter telescope, 17: 16422 (ISS-62/4)
MATTHIAS, B. T., Knight shifts in Nb–Mo alloys, 17: 16709
MATUSZEK, J. M., Jr., Isomeric ratios in $Nb^{93}(\alpha,xn)$ reactions, 17: 16047 (TID-18261(p.1-14))
MATYASOVA, J., Effect of radiation on deoxyribonucleoproteins, 17: 15789
MAUTZ, C. W., Viscous flow of ablating grease films, 17: 16224 (GAMD-2237)
MAWARDI, O. K., Measurements on current sheets in plasmas, 17: 16887
MAXWELL, A., Catalog of solar radio bursts, 17: 16912
MAYDEW, R. C., Turbulent mixing of axisymmetric compressible jets, 17: 16177 (SC-4764(RR))
MAYFIELD, R. M., Facility 350 He–atmosphere system, 17: 16171 (ANL-6489)
MAYNARD, N. C., Color centers in mixed crystals of alkali halides, 17: 16759
MC CLELLAND, J. D., Beryllium compounds, 17: 16715
MC CLURE, J. W., Direct (p, n) reaction in medium A nuclei, 17: 17226
MC CORMACK, Maxwell L., Methyl bromide for increasing I-131 uptake by pine trees, 17: 15735
MC CORMICK, J. F., Effects of ionizing radiation on a natural plant community, 17: 15727
MC CORMICK, J. Franklin, Effects of radiation on plant community, 17: 15801
MC COUBREY, Arthur O., Nuclear maser, 17: 16908
MC COY, H. E., Jr., Influence of CO–CO_2 environments of calibration of Chromel-P–Alumel thermocouples, 17: 16526 (ORNL-TM-481)
MC COYD, Gerard C., Scattering of electrons by H atoms. IV., 17: 16847
MC DANIEL, E. W., Atomic collisions in space phenomena, 17: 16886
MC DANIEL, E. W., Prog. rpt. on ionization of alkali ions, 12/62–2/63, 17: 16792 (TID-18258)
MC DONALD, Donald G., Polarization of protons scattered by He-3, 17: 17296
MC DONALD, Frank B., Solar cosmic rays, 17: 16939
MC DONALD, John R., Sarcoma-like tumors of skin following irradiation, 17: 15806
MC FARLAND, Robert H., Polarization of light emitted by He atoms, 17: 16842
McFARLING, James L., Enhanced catalytic activity from irradiation of catalysts, 17: 16040 (BMI-1620)
MC GEE, J. D., Symposium on photo-electronic image devices, London, 9/61, 17: 16394
MC GRATH, Robert G., Reactor fuel handling system, 17: 17523
MC HENRY, R. E., Extraction recovery of irradiated U, 17: 16145 (ORNL-3312)
MC KEOWN, M., Decay schemes in Os–Ir region. III., 17: 17213
MC KISSON, R. L., Prog. rpt. on thermionic energy conversion, 11/61–10/62, 17: 16769 (AI-7979)
MC LENEGAN, D. W., Drive for pumps of large reactor, 17: 17414 (HW-SA-2922)
MC LENNAN, E. A., Recombining atomic N with plasmas, 17: 16888
MC LEOD, D., Search for photoproduction of η^0 meson, 17: 16987
MC NALLY, J. R., Jr., Attainment of high density and current of hot protons in magnetic-mirror device, 17: 17338 (ORNL-3392(p.89-93))
MC NALLY, J. R., Jr., Vacuum arc research, 17: 17333 (ORNL-3392(p.47-8))
MC PHERSON, R., Note on 2320-kev level in Zn-68, 17: 17142
MC TIGUE, P. T., Oxidation of aldehydes with Br and D isotope effects, 17: 16037
MC WILLIAMS, Joseph Anthony, Producing electrical energy from nuclear fuel, 17: 17586
MEDAWAR, P. B., Immunological reaction against skin homografts in mice, 17: 15758
MEDVEDEV, V. K., Effect of electron bombardment on adsorption properties of W surfaces, 17: 16713
MEECHAN, C. J., Recovery of electrical resistivity of cold-worked Th, 17: 16651 (NAA-SR-Memo-1522)
MEGERTH, F. H., Irradiation of reactor control materials, 17: 16737 (GEAP-3927)
MEGHREBLIAN, R. V., Fission-fragment conversion reactors for space, 17: 16189
MEHLING, O., Decay scheme for β transition Ag-110m → Cd-110, 17: 17251
MEHTA, M. L., Singularities of t-matrix after canonical transformation, 17: 16978
MEIISEL, P., Occurrence of hypothyroidism after I-131 resection, 17: 15552
MEINHOLD, C. B., Dosimetry for γ field irradiation facilities, 17: 15732
MEINKE, W. Wayne, Thermal neutron activation analysis of Ti, 17: 15884 (TID-16522)
MEIZEROV, E. S., Effects of chronic irradiation on high nervous system in rats, 17: 15744
MEKHEDOV, V. N., Secondary reactions of d and t capture, 17: 17116 (JINR-P-1157)
MELCHING, H. J., Chemical protectors against radiation, 17: 15826
MELCHING, Hans-Joachim, Biological radiation protection. XLVII., 17: 15754
MELCHING, Hans-Joachim, Influencing radiation sensitivity of mammals, 17: 15753
MELVILLE, George S., Jr., Protection against ionizing radiation,

17: 15633 (SAM-TDR-62-103)
MENNEN, J., Welding plates for reactor construction, 17: 17438
MERCER, R. A., Chemical nature of Na beryllate solutions, 17: 16002
MERCIER, Jacques, Nature and production of active forms of H, 17: 15864
MERCIER, Jean, Pressure vessel construction, 17: 16212
MERGEN, F., Gamma irradiation of pitch pine-oak forest, 17: 15730
MERICLE, L. W., Cumulative radiation damage in oak trees, 17: 15734
MERICLE, R. P., Cumulative radiation damage in oak trees, 17: 15734
MERKLIN, J. F., Radiation chemistry of organic liquid mixtures, 17: 15768
MERRILL, J. R., Magnetoplasma resonance in metals, 17: 16841
MERRINER, Delbert L., Gas-filled dosimeter, 17: 16480
MERTE, Herman, Jr., Prog. rpt. on low heat flux boiling, 10/61–1/62, 17: 16231 (TID-15719)
MERTEN, U., Electrical resistivity of stabilized zirconia, 17: 16683
MERZ, Kenneth M., Thermal expansion of UP_2O_7, 17: 16680
MESSER, J. R., Boron compounds for neutron capture therapy. I., 17: 15575
MESSERSCHMIDT, Otfried, Biological radiation protection. XLVII., 17: 15754
MESTRE, E., Treatment station for solid radioactive waste, 17: 17614 (CEA-2195)
MESTVIRISHVILI, M. A., Properties of meson–nucleon vertex portion, 17: 16966
METHFESSEL, S., Gd_4Bi_3,—new ferromagnetic compound, 17: 16670
MEWISSEN, D. J., Radiation lesions, radiation cancers, and chemical radiation protection, 17: 15846
MEYER, A. S., Gas-cooled reactor project analyses, 17: 15855 (ORNL-3397(p.38-54))
MEYER, Edward, Concentric-cylindrical reactor fuel element, 17: 17519
MEYER, H., Phase boundaries of solutions of ZrO_2 and MgO, 17: 15975
MEYER, L. H., Purification of H-3 by electrolysis, 17: 16489 (DP-261)
MEYERHOFF, A., Design of top grid structure for EGCR, 17: 17558 (TID-18237)
MEYEROTT, A. J., Soft particle detectors, 17: 16897
MEYLAN, J.-L., Loop for irradiation of organic fluids, 17: 16074
MICHEL, R., Shear test of AGOT graphite, 17: 16659 (TID-18246)
MICKELSEN, William R., Heavy-particle electrostatic thrustors, 17: 16872
MIESCHER, P. A., Diagnosis of anemic states, 17: 15577
MIHAILOVIC, M. V., Radiative capture of 14-Mev neutrons in Al-27, 17: 17207
MIHAILOVIC, M. V., Structure of the giant resonance, 17: 17160
MIKAWA, Ryuzo, Blood picture and bone marrow in A-bombed survivors, 17: 15828
MIKHAILENKO, I. E., Effect of radioactive emission from Na_2WO_4 and Na_2SO_4 on phase transformations, 17: 16066
MIKHAILOV, V. F., Primordial transuranium isotope in nature, 17: 16274
MIKHAILUS, F. F., Resonance absorption of neutrons, 17: 17467
MILFORD, S. N., Scattering of electrons by H atoms. IV., 17: 16847
MILINCHUK, V. K., Radicals in γ irradiation of solid ammonia and hydrazine, 17: 16093
MILLER, A. D., Thermal decomposition of UC, 17: 15955 (PWAC-378)
MILLER, C. E., Jr., Release of fission products on in-pile melting of fuels, 17: 16324 (ORNL-3401(p.27-35))
MILLER, C. F., Electrical resistivity of stabilized zirconia, 17: 16683
MILLER, Clayton S., Tunnel diode as fast discriminating switch, 17: 16382 (IDO-16823)
MILLER, D., K^- interactions in D: π^-pY final states, 17: 16981
MILLER, E., Excretion of Na-22 in sweat, 17: 15700
MILLER, E. K., Wave propagation in glow discharge, 17: 16889
MILLER, G. L., Production of semiconductor detectors by Li drifting, 17: 16898
MILLER, R. P., Chemical nature of Na beryllate solutions, 17: 16002
MILLER, W. F., Computers in experimental physics, 17: 16789 (TID-18145)
MILLER, W. N., Restrained bowing of fuel element, 17: 16661 (TRG-Report-441)
MILLS, H. L., Effects of γ radiation on pinyon pine, 17: 15733
MILMAN, Miriam, Reaction following neutron capture in organic halides, 17: 16076
MILWARD, G. L., Chemical nature of Na beryllate solutions, 17: 16002
MIMURA, Yositaka, Wave geometry, 17: 16859
MINENKO, A., Analysis of nuclear fission products, 17: 15892
MINER, W. N., Dilatometry and thermal analysis of Pu metal, 17: 16561
MINER, W. N., Metal Pu, 17: 16550
MINKOWYCZ, W. J., Turbulent boundary-layer flow longitudinal to circular cylinder, 17: 16242
MINSHALL, F. S., Behavior of Fe–Si alloys under impulsive loading, 17: 16649 (LADC-5396)
MINZATU, I., Angular distribution of polarized neutrons from $Li^7(p,n)Be^7$, 17: 17167
MIQUEL, Jaime, Effects of α particle radiation on rat brain, 17: 15695
MIRABAL, Julius A., BEAM I: beams on elastic foundations, 17: 16173 (KAPL-M-JVM-4)
MISAO, T., Abnormalities observed in atom bomb survivors, 17: 15824
MISAO, Tando, Blood picture and bone marrow in A-bombed survivors, 17: 15828
MISHIMA, Yoshitsugu, Characteristics of several refractory metals, 17: 16712
MISRA, A. L., Preparation of H^3-labeled normorphine and physiology, 17: 15601
MISRA, A. L., Preparation of H^3-labeled morphine and biotransformation, 17: 15602
MITCHELL, A. C., Level structure of Ni-64 and Zn-64, 17: 17239
MITCHELL, Keith James, Improvements in fuel element arrangements, 17: 17483
MITCHELL, W. C., Progress of fruit-fly control by irradiation, 17: 15560
MITTAL, M. L., Amperometric determination of Ce(III) as molybdate, 17: 15907
MITTAL, Mohan Lal, Titrations of trivalent Ce with alkali molybdate, 17: 15997
MIXER, Robert Y., [Effects of radiation on] adhesives, 17: 16103
MIYAI, Kiyoshi, Estimating hepatic clearance with use of I^{131}-rose bengal and colloidal Au-198, 17: 15611
MIYANAGA, I., Effects of relative humidity on film emulsion, 17: 16459
MIYAZAKI, Yukio, Measurements of slow neutrons in Pacific and Indian Oceans, 17: 16933
MOCHEL, Walter E., Diamines having two deuterium atoms, 17: 16039
MOELLER, C., Gravitational energy radiation, 17: 16832
MOELLER, T., Observations on rare earths. LXXV., 17: 16001
MOFFAT, J. W., Singularities in angular momentum plane, 17: 17021
MOH, C. C., Radiation-induced mutations and radiation effects in coffee, 17: 15565
MOHANRAO, G. J., Measurement of Cs fallout in Pacific Ocean, 17: 16299
MOHANRAO, G. J., Variation of Cs-137 in California coastal sea water, 17: 16300
MOLCHANOV, V. A., Breakdown of metals by ion beams, 17: 16818
MOLL, G., Automatic recorder for G-M counter characteristics, 17: 16444
MONAGHAN, Ralph, Activation analysis of ocean bottom cores, 17: 15886 (TID-18125)
MONAGHAN, Ralph, Instrumentation for lunar surface analysis, 17: 16894
MONAGHAN, Ralph, Method for γ ray spectral analysis, 17: 16408
MONAGHAN, Ralph, Sediment density meter, 17: 16372 (TID-18124)
MONFILS, Andre, Absorption spectra of the H_2, HD, and D_2. IV., 17: 15977
MONFILS, Andre, Absorption spectra of H_2, HD, and D_2. V., 17: 15978
MONTELATICI, V., Magnetic polarization of nuclei, 17: 17121 (LNF-62/102)
MONTI, D., Study of 224 τ^+ decays, 17: 17007
MONTI, H., Micrography of Pu, 17: 16565
MONTI, L. M., Mutations in *durum* wheat induced by radiations, 17: 15731
MONTWILL, A., π^+ Decay of He hypernucleus, 17: 17190
MONTY, Kenneth J., Radiation effects on animal tissues, 17: 15631 (NP-12601)
MOORE, Alan, Process for working Be, 17: 16618
MORAN, H. S., Collimator study for 20-Bev electron beam, 17: 17315 (ORNL-TM-524)
MOREAU, Claude, Reactions of CO_2 on U, 17: 15980
MORENO-CASTRO, R., Thermal columns and access tubes for EGCR, 17: 17569 (TID-18249)
MORGAN, Karl Z., Effects of radiation on man, 17: 15634 (TID-15964)
MORGAN, R. L., Fractionated x-ray treatment of skin of pigs, 17: 15662
MORGAN, W. R., Prog. rpt. on Pu recycle, 7–9/62, 17: 16738 (GEAP-4081)
MORI, Shigeki, Elastic scattering of photons. II., 17: 17153
MORIKAWA, Susumu, Clinical use of 6-Mev betatron, 17: 15544
MORITA, Tomi, Effect of radiation on protein metabolism, 17: 15750

MOROZOV, V. N., Solutions for kinetic equations developed by S_n method, 17: 17463
MORRILL, Sonia D., Effects of depilatory x irradiation on hair growth in mice, 17: 15822
MORRIS, George Vincent, Thermal decomposition of Cs superoxide, 17: 16026
MORRIS, J. B., Removal of I vapor from air with Cu, 17: 16008
MORRISON, David L., Fission-product migration in and release from Fe–20 wt % Cr, 17: 16638 (BMI-1611)
MORRISON, R. T., Radioiodine uptake studies in newborn infants, 17: 15600
MORSE, J. G., Energy for remote areas, 17: 16190
MOSER, F., Hypertonia, nephritis, and nephrofibrosis after kidney irradiation, 17: 15709
MOSER, P., Helium circuit for irradiation of fuel element, 17: 16756
MOSKALEVA, L. P., Formation mechanism of light nuclei, 17: 17149
MOSKVIN, N. A., Spectra of crystals of alkali fluorides with U, 17: 15981
MOTEFF, J., Neutron irradiation effects in A-286, Hastelloy X and René 41, 17: 16745 (TID-18150)
MOTLEY, R. W., Low-frequency oscillations in a K plasma, 17: 17362
MOULI, Chandra, Radiation-induced free radicals and identification, 17: 15763
MOULTON, R. W., Transients following He line failure at PRTR pressurizer, 17: 17540 (HW-75731)
MOULTON, R. W., Two-phase critical flow of steam-water, 17: 16239
MUCHNIK, M., Fission of U, Th, and Bi by 20-Bev protons, 17: 17180
MUEL, Bernard, Excitation of delayed fluorescence, 17: 16813
MUELLER, A., Radical production by x-rays, 17: 15767
MUELLER, John H., Inorganic surfactants in liquid-liquid extraction systems, 17: 16144 (NLCO-867)
MUELLER, K. H., Ceramic materials containing rare earths, 17: 17434
MUELLER, V. F., Decay $\pi \rightarrow e + \nu + \gamma$, 17: 17048
MUENSTER, Hans-Juergen, Preparing an encased Kr-85 radiation source, 17: 16217
MUGNIER, Daniel, Martensite transformation of 18-10 steel, 17: 16531
MUKUNDA, N., Principles of classical dynamics, 17: 16786 (NYO-10250)
MULE, S. J., Preparation of H^3-labeled morphine and biotransformation, 17: 15602
MULLER, J. H., Radioactive isotope therapy, 17: 15800
MULLIKIN, T. W., Criticality problem for spheres and slabs, 17: 17425 (RM-3256-PR)
MUNTJEWERFF, W. F., Fluctuations in counting rate of photomultipliers, 17: 16456
MURAMATSU, Susumu, Genetic effects of low-dose irradiation on mice, 17: 15686
MURDOCK, J. F., Reaction between Be and UC, 17: 16537
MURIN, A. N., Regularities in α decay of nuclei with less than 126 neutrons, 17: 17256
MURPHY, P. G., Elastic K^+-proton scattering, 17: 17015
MURPHY, T., Dose received in 13 weeks and 50 years by body tissues, 17: 16311 (AHSB(RP)R-20)
MURR, William E., Annealing studies on irradiated type 347 stainless steel, 17: 16733 (BMI-1621)
MURRAY, J. J., K^- interactions in D: $\pi^- pY$ final states, 17: 16981
MURRAY, Joseph J., Spin and parity of Y_1^* resonance, 17: 17040
MURTHY, T. K. S., Determination of small amounts of long-chain aliphatic amines in aqueous solution. II., 17: 15906
MUTO, V., Effects of splenectomy in animals subjected to irradiation, 17: 15811
MUTO, V., Spleen factor protective against radiation syndrome, 17: 15812
MU-TSUNG, Radiative decays of resonance states, 17: 17119 (JINR-P-1164)
MUUGA, I., Sensitized luminescence of $Ca_3(PO_4)_2$–Ga, Mn, and $Ca_3(PO_4)_2$–In, Mn, 17: 16088
MUZINICH, Ivan, Invariant scattering amplitudes for arbitrary spins, 17: 17035

N

NAGAI, Ojiro, Scattering of neutrons by $FeCl_3$, 17: 16006
NAGEL, Bengt, Matrix elements in an angular momentum representation, 17: 16962
NAGY, L., Angular distribution of γ rays from fission of U-235, 17: 17203
NAJZER, M., Radiative capture of 14-Mev neutrons in Al-27, 17: 17207
NAKAMURA, Eiko, Complex compounds of NP(IV), 17: 16075
NAKAMURA, Mitsuru, Survival of uv-irradiated *Shigella sonnei*, 17: 15721
NAKAMURA, Takashi, Prog. rpt. on liquid coolants, 1/28/61–1/31/62, 17: 16031 (TID-17275)
NAKAMURA, Takeze, Plasma arc torch, 17: 16220
NAKANO, George H., East-west asymmetry in geomagnetically trapped protons, 17: 16918 (UCRL-10587)
NAKANO, Makoto, Spectrochemical analysis of Nb–Ta mixtures, 17: 15899
NAKANO, Yoshiei, Helical instability in positive column in magnetic field, 17: 17352
NAKAYAMA, Yasuyuki, Internal conversion of 1277-kev transition in Ne-22, 17: 17170
NALIMOV, V. V., Model for extraction of Hf and Zr with TBP, 17: 16165
NALIMOV, V. V., Optimum conditions in extraction of Hf with TBP, 17: 16166
NAMIKI, Mitsuo, Effects of alkali halides on radiation inactivation of taka-amylase in aqueous system, 17: 15592
NARAGHI, M., Measurements on current sheets in plasmas, 17: 16887
NARIN, Francis, Computer data processing system for Rover, 17: 16504 (LAMS-2845)
NARTOVA, T. T., Strength of Ti alloy based on Ti_3Al, 17: 16677
NASSER, Essam, Ionizing potential at spark discharges, 17: 16865
NAUMKIN, O. P., Magnetic properties of Sc, 17: 16723
NEAL, R. B., Design of Stanford two-mile accelerator, 17: 17316 (SLAC-7)
NEBENZAHL, I., Correlation between spectra and neutrons evaporated, 17: 17162
NEDUMOV, N. A., Data on system Ti–B–Cr, 17: 16711
NEEL, L., Order-disorder transition in Fe–Ni, 17: 16701
NEELAKANTAN, K. A., Spectrum of heavy primary cosmic radiation, 17: 16932
NEELY, James V., Design requirements for EGCR core structure, 17: 17560 (TID-18239)
NEHRIG, D. A., Boron stainless steel control rods for Pathfinder, 17: 17531 (ACNP-63001)
NEIDIGH, R. V., Optimum energy for plasma confinement, 17: 17365
NELKIN, Mark, Solutions of transport equation for thermal neutrons, 17: 17090 (GA-3298)
NELSON, Joseph F., Irradiated petroleum resins, 17: 16116
NEMETS, O. F., Spins and parities of some states of Mo isotopes, 17: 17258
NEMILOV, Yu. A., Neutron polarization in $C^{13}(d,n)N^{13}$ reaction, 17: 17264
NEMILOV, Yu. A., Polarization of 6,5-Mev deuterons scattered on Ti, Fe and Ni, 17: 17263
NEMIROVICH-DANCHENKO, O. R., Effect of Po on intestinal microflora of dogs, 17: 15815
NEMODRUK, A. A., Interaction of U(VI) with arsenazo III strongly acid solutions, 17: 15931
NERSES, V., Prog. rpt. on ribbed Be tubing extrusion, final, 5/61, 17: 16607 (NMI-4950)
NESTERIN, M. F., Disturbance and restoration of G-I tract during radiation sickness, 17: 15838
NEUMANN, H. A., Measuring the mosiac spread width of crystals, 17: 16811
NEUZIL, E. F., Helium ion fission of Au-197, Pb-204, and Pb-206, 17: 17224
NEVILLE, Donald E., Σ^- capture in deuterium, 17: 17240
NEWELL, R. R., Late sequelae of irradiation in man, 17: 15665
NEWMAN, Kenneth Walter, Radioactive decontamination of Co alloys, 17: 15869
NEWMAN, Kenneth Walter, Removing contaminants from surfaces, 17: 15868
NEWTON, Amos S., Chemical effects of ionizing radiation, 17: 16096
NEWTON, Amos S., Interaction of radiation with matter, 17: 16095
NEWTON, R. R., Graphite core structure for EGCR, 17: 17571 (TID-18251)
NGOC, Hoan Nguyen, Electron decay of Be-9, 17: 17144
Nguyen Ngoc, Hoan
see Ngoc, Hoan Nguyen
NIAS, A. H. W., Fractionation effects by erythema measurements on human skin, 17: 15661
NICHOLS, D. K., Prog. rpt. on radiation effects on Si solar cells, 12/61–

12/62, 17: 16736 (GA-3872)
NICHOLS, J. P., Radiochemical-plant safety, 17: 16329 (ORNL-3401 (p.63-72))
NICHOLSON, C. K., Purification of H-3 by electrolysis, 17: 16489 (DP-261)
NICHOLSON, W. J., Spin Hamiltonian parameter D vs. axial crystal field for S-state ions, 17: 17210
NICKOLS, Norris A., Muon scattering in Fe, 17: 17228
NICOLO, Georges, Diode pump application to nuclear particle counting, 17: 16420 (CEA-2185)
NIEBUHR, Johannes, X-ray spectrum analysis of Ta and Cb, 17: 15900
NIEDERPRUEM, H., Radiation-catalyzed addition of organosilicon hydrides to organovinylsilanes, 17: 16068
NIELSEN, Lloyd Carlisle, Decay of bound muons in Ti, Fe, and Pb, 17: 17297
NIELSEN, S. O., Solid state processes in irradiated serum albumin, 17: 15772
NIILISK, A., Luminescence of phosphors activated with Eu, 17: 16862
NIKANOROV, V. I., Elastic π-σ scattering at high energies, 17: 16951 (JINR-P-1150)
NIKITIN, M. K., Ion-exchange reactions in HF solutions, 17: 16152
NIKITIN, M. K., Positron decay of Re-182, 17: 17259
NIKOLAEV, N. I., Equations for countercurrent ion-exchange column for isotope separation, 17: 16492
NIKOLAISHVILI, Sh. S., Angular distribution of neutrons emitted by spherical isotropic sources, 17: 17458
NIKOLAISHVILI, Sh. S., Spatial-energy distribution of fast neutrons in H, 17: 17460
NIKOLAISHVILI, Sh. S., Spherical harmonics in transport theory. P_n approximation, 17: 17456
NIKOLAISHVILI, Sh. S., Spherical harmonics in transport theory. P_3 approximation, 17: 17457
NISEL'SON, L. A., Preparation of Ta and Nb by reduction of pentachlorides, 17: 16548
NISHI, T., Effects of relative humidity on film emulsion, 17: 16459
NISHIHARA, Hideaki, Effects of ship motion on boiling water reactors, 17: 17578
NISHIWAKI, Y., Biological actions of radiations. I., 17: 15701
NISHIWAKI, Y., Biological actions of radiations. II., 17: 15703
NITTO, Mitsutoru, Process analysis of post-activation method, 17: 15913
NIZIOL, B., Analysis of spectrum of ionization pulses caused by nuclear active particles, 17: 16919
NOBLES, R. A., Soft particle detectors, 17: 16897
NONAMI, Y., Effects of γ irradiation on lipids of chicken egg yolk, 17: 15723
NORDLING, Carl, Auger spectra in intermediate coupling region, 17: 16810
NORDLING, Carl, Photoelectron method of determining h/e, 17: 16809
NORTON, Horace W., Prog. rpt. on wholesomeness of irradiated food, 17: 16364 (NP-12602)
NOSHKIN, Victor E., Jr., Recoil studies of U fission fragments, 17: 16051 (TID-18261(p.27-43))
NOTANI, N. K., Radiation-induced free radicals and identification, 17: 15763
NOTANI, N. K., Radiosensitivity of maize and moisture content, 17: 15799
NOVAKOVA, J., Exchange reactions of O-18 with oxidation catalysts. I., 17: 15979
NOVOSELOVA, A. V., Rhombic modification of BeF_2, 17: 16673
NOWAK, M. J., Non-steady radiation transport and thick-thin approximation, 17: 16777 (GAMD-3095)
NOWAK, M. J., Some fundamental properties of shock waves, 17: 16776 (GAMD-2288)
NOWELL, P. C., Hepatomas in fast-neutron-irradiated mice, 17: 15643 (USNRDL-TR-596)
NOWIK, I., Hyperfine interactions in states of Tm-169, 17: 17187
NOWOTNY, Hans, Structure and stability of refractory phases, 17: 16666
NOZAKI, Tadashi, Synthesis and purification of quinquiphenyl for scintillator, 17: 16036
NUSSIM, M., Secondary H isotope effects. I., 17: 15990
NUSSIM, M., Secondary H isotope effects. II., 17: 15991
NUSSINOW, S., Discussion of a $3^-/2$ octet, 17: 16993
NUYTS, J., Violation of $|\Delta I| = \frac{1}{2}$ rule, 17: 16996
NYSTEN, K. E., 992 Kev $Al^{28}(p,\gamma)Si^{29}$ resonance, 17: 17200

O

OBARA, Tetsujiro, Polarographic studies on storage of meats. XIX., 17: 16379
OBERHAUSEN, E., Reasons for the enrichment of Cs-137 in organisms, 17: 15621
OBERMAN, Carl, Effect of ion correlations on plasma conductivity, 17: 17358
OBERMAN, Carl, High-frequency conductivity of fully ionized plasma, 17: 17325 (MATT-130)
O'CONNELL, R. F., Gell-Mann–Rosenfeld triangle for Σ decays, 17: 17000
ODENTHAL, H., Corrosion of Fe in O_2-containing condensate, 17: 16599
OEFJORD, K. J., NORA—zero-power experimental reactor facility, 17: 17595 (KR-41)
OEHME, Reinhard, Regge trajectories and elementary poles, 17: 17032
OEHME, Reinhard, Vector mesons and Pomeranchuk trajectory, 17: 17045
OELSNER-RYDE, Karin, Electron capture decay of Er-165, 17: 17136
OERVOES, Lasszlo, Preparation of phthaloylglycine-1-C^{14}, 17: 16035
OESER, Jan, Electron scattering studies: Cu-63, In-115, Ta-181, Pb-208, and Bi-209, 17: 17233
OFENGENDEN, R. G., Many-dimensional pulse analyzer, 17: 16464
OFENGENDEN, R. G., Small-size pulse-height analyzer, 17: 16465
OFER, S., g-Factor of 2.083-Mev 4^+ state of Ce-140, 17: 17194
OFER, S., Hyperfine interactions in states of Tm-169, 17: 17187
OFFENBERGER, A., Experiments with moving magnetized plasma, 17: 17345
OGASAWARA, Yosokichi, Polarographic studies on storage of meats. XIX., 17: 16379
OGDEN, H. R., Tensile properties of W, 17: 16639 (DMIC-Memo-157)
OGDEN, H. R., Titanium alloys which remain ductile after welding, 17: 16580
OGIEVETSKII, V. I., Forbidden meson configurations in multimeson decay, 17: 16952 (JINR-P-1161)
OHTA, Keizo, Properties of Fe–Be compounds, 17: 16704
OISHI, Y., Chirality and structure of π-N interaction, 17: 16989
OKADA, Minoru, Rapid analysis by radioactivation. I., 17: 15915
OKADA, Minoru, Rapid analysis by radioactivation. II., 17: 15916
OKADA, Minoru, Rapid analysis by radioactivation. III., 17: 15917
OKAZAKI, A., Physics of D_2O lattices, 17: 17402 (AECL-1684)
OKAZAWA, Yoshiko, Genetic effects of low-dose irradiation on mice, 17: 15686
OKAZAWA, Yoshishige, Effects of alkali halides on radiation inactivation of taka-amylase in aqueous system, 17: 15592
O'KELLEY, G. D., Stopping cross sections of low-energy tritons, 17: 17211
OKUBO, Susumu, Analyticity and unitarity conditions in scattering problems. II., 17: 16955 (NYO-10238)
OKUBO, Susumu, Regge's trajectory and domain of holomorphy, 17: 16956 (NYO-10239)
OLANDER, D. R., Hydrodynamic model of mass transfer in stirred vessel extractor, 17: 16241
OLDENDORF, W. H., Measuring brain blood flow with radioisotopes, 17: 15580
OLDS, Geoffrey Charles Edward, Improved magnesium alloys, 17: 16730
OLES, A., Analysis of spectrum of ionization pulses caused by nuclear active particles, 17: 16919
OLIVER, R., Cell survival data in relation to radiotherapy treatments, 17: 15660
OLIVER, R., Heavy metal shielding in compensators for Co-60 therapy, 17: 15663
OLIVER, Robert C., Separation of D from H, 17: 16501
OLKHOVSKII, V. S., Inelastic scattering of neutrons by nonspherical nuclei, 17: 17248
OLKHOVSKII, V. S., Scattering of neutrons by nonspherical nuclei, 17: 17246
OLP, R. H., Fabrication of EBR-II Core I fuel elements, 17: 16602 (ANL-6276)
OL'SHEVSKAYA, I. V., Determination of Sc in coal ash, 17: 15920
OLSSON, Per, Matrix elements in an angular momentum representation, 17: 16962
OLTE, A., Wave propagation in glow discharge, 17: 16889
O'MALLEY, Thomas F., Minimum principle for single-channel scattering,

17: 17029
ONDRACKOVA, J., Excretion of Na by saliva after irradiation in rats, 17: 15719
ONO, Atsuwo, Elastic scattering of photons. II., 17: 17153
ONO, Syu, Mechanics of transport phenomena in gases, 17: 16822
OPALINSKA, Irena, Effect of γ irradiation on catalytic activity of Ni, 17: 16084
O'RAIFEARTAIGH, L., Gell-Mann–Rosenfeld triangle for Σ decays, 17: 17000
ORBACH, Harry K., Separation of D from H, 17: 16501
ORDWAY, Frederick I., III, Advances in space science and technology. IV., 17: 17610
ORDWAY, Frederick I., III, Radioactive energy sources for spacecraft propulsion, 17: 17611
ORLOV, V. V., Effects of scattering on resonance absorption of neutrons, 17: 17468
ORMEROD, M. G., Hypothesis for radiosensitization by O, 17: 15795
ORNSTEIN, H. L., Prog. rpt. on heat rejection in space power plants, 9–11/62, 17: 16230 (PWA-2132)
ORO, J., Synthesis of organic compounds by electric discharges, 17: 15579
ORO, J., Synthesis of organic compounds by high-energy electrons, 17: 16072
O'ROURKE, J., Behavior of Fe–Si alloys under impulsive loading, 17: 16649 (LADC-5396)
O'ROURKE, J. A., Oxide films on γ phase U alloys, 17: 16536
ORSELLO, U., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
OSBORNE, Denis Anthony Norman, Curing of polymeric compositions, 17: 16114
OSIPOV, A. I., Nonequilibrium distribution of energy in gases, 17: 16864
OSTAPENKO, V. I., Radiation effects on morphological changes in plants, 17: 15749
OSTERBERG, Charles, Radioactivity in large marine plankton, 17: 15609
OSTROUMOV, E. A., Cinnamic acid in analytical chemistry. III., 17: 15924
OSTROWSKY, Howard Sherman, Positron annihilation in NaF, 17: 17301
OVERSTREET, Roy, Uptake of Sr by roots of *Zea mays*, 17: 15610
OVRUTSKAYA, R. M., Effect of additions of oxides on Mg–Mn ferrites, 17: 16019
OWEN, Ray D., Loss of tolerance following irradiation, 17: 15761
OWEN, Richard Bruce, Gamma ray thickness gages, 17: 16407
OYAMADA, Masayuki, Photoprotons from S-32, 17: 17155

P

PADERNO, Yu. B., Resistivity of hexaborides of rare-earth metals, 17: 16726
PADGETT, C. E., Metallographic preparation of Zy-2, 17: 16656 (TID-16475)
PADUART, A., Symposium on calculation methods of shell structures, Brussels, 9/61, 17: 16192
PAGE, Robert William, Nuclear reactor core, 17: 17489
PAGE, William A., Shock-layer radiation of blunt bodies, 17: 15539
PAINE, R. M., Prog. rpt. on high-temperature intermetallic compounds, annual, 1961, 17: 16637 (BBC-115)
PAK, W., Field reversal in tenuous plasma, 17: 16790 (TID-18216)
PALADINO, A. E., Diffusion-controlled processes in Al_2O_3, 17: 16679
PALECEK, E., Effect of DNA on chromosomal aberrations in bone marrow, 17: 15788
PALMO, V., 2-Methylpiperazine dithioformate: liver and radio protector, 17: 15809
PALOCZ, Istvan, Approach to Cherenkov and Smith-Purcell radiation, 17: 17081
PAN, V. M., Chromium–Nb–Ti alloys, 17: 16543
PANTALEO, R., Activity of reticulo-endothelial system investigated with radio-Au colloids, 17: 15715
PAOLETTI, R., 2-Methylpiperazine dithioformate: liver and radio protector, 17: 15809
PAPKOW, A., Nuclear reactions inside cyclotron chamber, 17: 17135
PAREDES, Julio Bedoya, Radioactive I in diagnosis of thyroid disorders, 17: 15550
PARIA, Gunadhar, Transient effect on superconducting sphere under influence of varying magnetic field, 17: 16816
PARKER, C. E., Magnetics and superconductivity, 17: 17336 (ORNL-3392(p.66-85))
PARKER, E. N., Discussion of hydrodynamic models of solar corona, 17: 16914
PARKER, F. L., Prog. rpt. on waste disposal, 8–10/62, 17: 17619 (ORNL-TM-482)
PARKER, G. W., Fission product transport evaluations, 17: 16326 (ORNL-3401(p.39-43))
PARKER, G. W., Release of fission products on out-of-pile melting fuels, 17: 16323 (ORNL-3401(p.5-27))
PARKER, G. W., Release of fission products on in-pile melting of fuels under transient conditions, 17: 16325 (ORNL-3401(p.35-9))
PARKINSON, William W., [Effects of radiation on] polymers, 17: 16098
PARKINSON, William W., [Effects of radiation on] plastics, 17: 16099
PARSLY, L. F., Nuclear safety pilot plant, 17: 16328 (ORNL-3401 (p.57-60))
PARSONS, J., Excretion of Na-22 in sweat, 17: 15700
PARTHE, Erwin, Structure of WC by neutron and x-ray diffraction, 17: 16708
PASECHNIK, L. L., Escape of charged particles from plasma, 17: 17379
PASEK, Miroslav, Purification of liquid Na coolant, 17: 17436
PASINETTI, A., Renal lesions from ionizing radiation. I., 17: 15712
PASINETTI, A., Renal lesions from ionizing radiation. II., 17: 15713
PATARAYA, A. D., Propagation of shock wave in plasma, 17: 17377
PATE, B. D., Production of semiconductor detectors by Li drifting, 17: 16898
PATEL, C. K. N., Media exhibiting population inversion, 17: 17374
PATERA, I., Strange particle production, 17: 16953 (JINR-P-1163)
PATERSON, Edith, Bone-marrow treatment of irradiated rhesus monkeys, 17: 15821
PATTERSON, D. A., Boron stainless steel control rods for Pathfinder, 17: 17531 (ACNP-63001)
PAUL, P., Alpha spectra from d reactions on Li-7, 17: 17223
PAULA E SILVA, P. R., Unusual statistics of elementary particles, 17: 16977
PAULEVE, J., Order-disorder transition in Fe–Ni, 17: 16701
PAVDERNIK, J., Measurement of radioactivity at Czechoslovak water works, 17: 15616 (JPRS-18391)
PAVLENKO, Yu. G., Two-nucleon spin-orbital interactions, 17: 17047
PAVLIKOVSKII (Pavlikovsky), A., Calculations of strongly deformed element properties using superfluid nuclear model, 17: 17113 (JINR-E-1154)
PEARL, W. L., Stress corrosion of Ni alloys in reactor environment, 17: 16587 (GEAP-4165)
PEARLSTEIN, R. M., Search for slow component in α ionization, 17: 16849
PEARSE, Cabell A., Ground-based high-altitude detection systems, 17: 16899
PEARSON, D. P., Properties of nitrate solutions of Fe–Ni-base nuclear fuels, 17: 16142 (IDO-14602)
PEARSON, E. N., Relationship of carburizing potential to operating temperature limitations in SRE, 17: 17597 (NAA-SR-Memo-7804)
PEDIGO, Robert Allan, Effects of radiation on *Pinus taeda L.*, 17: 15802
PEKAR, S. I., Electron theory of crystals, 17: 16795 (AEC-tr-5575)
PELLEGRINI, C., Effects of rotation of median plane on particle orbit, 17: 17313 (LNF-62/95)
PELLINI, W. S., How neutron exposure alters reactor steels, 17: 16752
PEMSLER, J. P., Cracking of oxide films on Zr in steam, 17: 16590 (NMI-1254(p.3-43))
PEMSLER, J. P., Surface oxide films on Zr, 17: 16591 (NMI-1254(p.44-65))
PENNEY, Gaylord W., Ionization of gas by radiation from discharge, 17: 16812
PENNINGTON, R. T., Prog. rpt. on nuclear superheat fuel development 5/4–8/31/62, 17: 17538 (GEAP-4105)
PENZIEN, J., Analysis of stress concentrations in thin spherical shells, 17: 16664 (UCRL-13064)
PEPPARD, D. F., Magnetic resonance studies of acidic organophosphorus compounds, 17: 16034 (TID-18170)
PEPPER, Thomas P., Direct measurement of mass per unit area, 17: 16401
PEREZ, Juan Carlos, Prog. rpt. on radiation effects on muscle membrane, final, 4/15/62–4/15/63, 17: 15642 (TID-18268)
PEREZ, Juan Carlos, Radiation damage in muscle cell membranes,

17: 15641 (TID-18221)
PEREZ-BUSTAMANTE, J. A., Reaction of uranyl hydroxide with carbonic acid intermediate step in obtaining uranyl carbonate, 17: 15969
PEREZ Y JORBA, Joan, Electron decay of Be-9, 17: 17144
PERKINS, Frank C., Prog. rpt. on oxidation of beryllides, 12/62–3/63, 17: 15947 (DRI-2088)
PERKINS, R. B., Polarization in neutron-proton scattering at 23.1 Mev, 17: 17024
PERLMAN, M. L., Decay schemes in Os–Ir region. III., 17: 17213
PERROUD, Paul, Ionization-type heat exchange process, 17: 16257
PERSSON, Lars, Electron capture decay of Er-165, 17: 17136
PESCHEL, Manfred, Electric potential and field pattern in ionization chambers, 17: 16462
PETER, M., Paramagnetic resonance of Gd^{3+} in Pd, 17: 16819
PETERKOP, R. K., Resonances in scattering of electrons on H atoms, 17: 17270
PETERS, E. G., Sorption effects on measurements under ultra-high vacuum, 17: 16184 (AERE-Trans-920)
PETERSEN, D. F., Neutron dose estimates in SL-1 accident, 17: 16315 (LADC-5359)
PETERSON, R. E., Problems in reactor theory and electrical engineering, 17: 17415 (HW-SA-2933)
PETERSON, R. W., Nitrogen-12 and B-12 β-decay measurements, 17: 17236
PETERSON, Robert W., Direct comparison of the B-12 and N-12 β spectra, 17: 17237
PETERSON, T. E., Boron stainless steel control rods for Pathfinder, 17: 17531 (ACNP-63001)
PETR, I., Synchroscope for studying fast processes, 17: 16461
PETRANY, Zoltan, Determining radioactivity in feces, 17: 15894
PETRICK, Michael, Carry-under phenomena in vapor liquid separation, 17: 16240
PETRINA, D. Ya., Analytic properties of scattering amplitude, 17: 17398
PETROV, E. E., Spatial and angular distribution of spherical source neutrons, 17: 17459
PETROV, R. V., Immunology in acute radiation sickness, 17: 15848
PETROVIC, S., Effects of x irradiation on RNA metabolism in rat liver, 17: 15798
PETROVIC, S., Liver DNA injected into lethally-irradiated rats. I., 17: 15797
PETROZZI, E., Chromatography reader, 17: 16450
PFLEGER, K., Reasons for the enrichment of Cs-137 in organisms, 17: 15621
PFOERTNER, Karlheinz, Direct-reading chemical radiation dosimeter, 17: 16479
PHILLIPS, R. J. N., Coulomb interference in high-energy p-p scattering, 17: 16999
PICARD, F., Angular distributions in (d,α) reactions, 17: 17171
PICK, James R., Prog. rpt. on effects of irradiated diet, 3/15–9/15/62 17: 16361 (NP-12598)
PICOU, J. L., Angular distributions in (d,α) reactions, 17: 17171
PICQUENDAR, Jean-Edgar, Characteristics of thermoelectric converters, 17: 16186
PIETSCH, E., Nuclear reactions inside cyclotron chamber, 17: 17135
PIJANOWRKI, E., Food preservation by irradiation in Poland, 17: 16373
PILCHER, F., Optical absorption of color centers in LiF containing Mg, 17: 15960 (TID-18146)
PILLSBURY, Donald M., Use and abuse of x-ray therapy for benign skin conditions, 17: 16347
PINKSTON, William T., Two-hole two-particle levels in Pb-208, 17: 17138
PINSLEY, Edward A., Oscillating-electron plasma source, 17: 17323 (ARL-62-471)
PIPKIN, F. M., Beta-decay matrix elements in Sb-122, 17: 17215
PITAEVSKII, L. P., Effects induced by fast-moving artificial satellite in ionosphere, 17: 16863
PIVOVAROVA, N. B., Low-energy π-π scattering, 17: 17059
PLANK, H. F., Vehicle design considerations, 17: 17612
PLANTA, A., Uses of radioactive isotopes in industry, 17: 16358 (JEN-73-SI/18)
PLATE, Patricia B., DMIC selected accessions, 2/63, 17: 16523 (NP-12632)
PLATT, R. B., Effects of ionizing radiation on a natural plant community, 17: 15727
PLOEGER, F., Method for producing UO_3 powder, 17: 16132
PLUHAR, Zdenek, Optical model of the atomic nucleus, 17: 17279
POBEDONOSTEV, L. A., Polarization of 6,5-Mev deuterons scattered on Ti, Fe and Ni, 17: 17263
POBLENZ, Frank W., Transistor failure in nuclear environment, 17: 16882
POCHIN, E. Eric, Contamination of milk by radioiodine, 17: 15605
POCOCK, C. E., Effect of gas content on ONB point for Santowax OM + 30 w/o HB, 17: 16228 (NAA-SR-Memo-8064)
POCOCK, Sydney Norman, Dose-rate indicating apparatus, 17: 16473
PODGORETSKII, M. I., γ Production in interaction of π^- mesons with nuclei, 17: 17192
PODGORETSKII, M. I., Radiative decays of resonance states, 17: 17119 (JINR-P-1164)
PODOLSKY, B., Magnetohydrodynamics, 17: 16788 (R58AGT967)
POGUDALINA, E. I., One-group theory in nuclear reactor calculations, 17: 17461
POGUDALINA, E. I., Spherical harmonics in transport theory. P_3 approximation, 17: 17457
POLACK, Frank M., Isotopic labeling of corneal stromal cells, 17: 15586
POLAKOWSKI, N. H., Fabrication procedures for high-quality tubing, 17: 16603 (ANL-FGF-409)
POLITOVA, E. (Ye.) M., Chronic radiation sickness induced by external irradiation, 17: 15805 (JPRS-18153)
POLIVODA, A. I., Luminescence of normal and irradiated liver tissue, 17: 15736
POLLEY, John R., Inactivation of influenza virus by γ radiation, 17: 15668
POLLYCOVE, Myron, Vitamin B_{12}-deficient and folic acid-deficient megaloblastic anemias, 17: 15549
Polonio, J. Bermudez
see Bermudez Polonio, J.
POLOTNYUK, V. V., Coercive force of deformed Ni alloys, 17: 16716
POLYAKOV, Yu. M., Preparation of Ta and Nb by reduction of pentachlorides, 17: 16548
POLYAKOVA, M. D., Data on system Ti–B–Cr, 17: 16711
PONTECORVO, B., Probabilities of $\mu^- + He^3 \rightarrow He^3 + \nu$ reaction, 17: 17278
PONTECORVO, Bruno, Neutrino and its role in astrophysics, 17: 16917
POP, I., Magnetic properties of Sc, 17: 16723
POPOV, A. I., Elastic scattering of protons by Mg-24, 17: 17261
POPOV, A. S., Radiation injury of paramecia, 17: 15737
POPOV, E. P., Analysis of stress concentrations in thin spherical shells, 17: 16664 (UCRL-13064)
POPOV, V. I., Gamma spectra in capture of thermal and fast neutrons, 17: 17255
POPOVA, A. M., Mechanism of the $C^{13}(p,p'3\alpha)$ reactions, 17: 17174
POPPE, C. H., Neutrons from proton bombardment of Li, 17: 17220
POPPE, Carl Hugo, Neutrons from d + t and d + h, 17: 17086
PORIES, Walter J., Strontium-90 in hair, 17: 15612
PORTELA, Adolfo, Prog. rpt. on radiation effects on muscle membrane, final, 4/15/62–4/15/63, 17: 15642 (TID-18268)
PORTELA, Adolfo, Radiation damage in muscle cell membranes, 17: 15641 (TID-18221)
PORTER, J. T., Jr., Electrical resistivity of stabilized zirconia, 17: 16683
PORTNOVA, S. I., γ Production of π^- mesons with nuclei, 17: 17192
PORTNOVA, S. I., Radiative decays of resonance states, 17: 17119 (JINR-P-1164)
POSEY, J. C., Extraction recovery of irradiated U, 17: 16145 (ORNL-3312)
POSTON, J. W., Temperature coefficients in ATRCE Core, 17: 17599 (TID-18254)
POTENZA, G., Fission of U, Th, and Bi by 20-Bev protons, 17: 17180
POTHMANN, Curt, X-ray spectrum analysis of Ta and Cb, 17: 15900
POTOCHNIK, Joseph F., Welding a reactor vessel, 17: 17440
POTTER, E. C., High-temperature reaction between steel and water, 17: 16601
POZWOLSKI, Alexandre, Action of uniform force field on gas, 17: 16821
PRANGE, R. E., Green's function method, 17: 17069
PRANGE, R. E., Large superfluid systems of fermions, 17: 17068
PRANGE, Richard E., Dielectric constant of a superconductor, 17: 16840
PRATS, F., Interaction matrix element in a shell model, 17: 17217
PREECE, George Edward, Nuclear reactor core, 17: 17489
PRENTKI, J., Violation of $|\Delta I| = \frac{1}{2}$ rule, 17: 16996

PRESLEY, Norman L., Radioisotope scanning for pericardial effusions, 17: 15582
PRESSESKY, Andrew J., Direct measurement of mass per unit area, 17: 16401
PRESTON, M. A., Physics of the nucleus, 17: 17280
PRICE, Colin Frederick, Improvements in heat exchangers, 17: 17474
PRINCE, Margaret Y., Solid solubility in metallic alloys, 17: 16518 (LADC-5380)
PRIOR, H. A., Vacuum fusion apparatus for determination of O in UC and PuC, 17: 15872 (AERE-R-4216)
PROBSTEIN, Ronald F., Comments on "Current-Layer Diffusion in One-Dimensional Pinch", 17: 17369
PROFIO, A. E., Prog. rpt. on D_2O lattice project, annual, 9/62, 17: 17419 (MITNE-26)
PROFT, Rudolf, Technology of Zr extraction, 17: 16533
PROKOPENKO, V. S., Inelastic scattering of 6,9-Mev protons by Cr isotopes, 17: 17266
PROSPERI, D., Gamma rays from thermal neutron capture in Ho, Tm, and Lu-I, 17: 17181
PRUETT, John R., Lifetime of 0.559-Mev level of Se-76, 17: 17211
PRUSCHEK, R., Reactor for energy requirements of electric propulsion, 17: 17608
PRUTKOVA, N. M., Optimum conditions in extraction of Hf with TBP, 17: 16166
PRYOR, A. W., Calculation of crystal and counter settings for collection of crystallographic data, 17: 15936 (AAEC/TM/179)
PRYOR, A. W., Crystallographic structure factor program for IBM 1620 computer, 17: 16767 (AAEC/TM-180)
PRZHEVUSKII, A. K., Spectra of alkali-earth fluoride crystals, 17: 16012
PSHEZHETSKII, S. Yu, Radicals in γ irradiation of solid ammonia and hydrazine, 17: 16093
PUCHEROV, N. N., Inelastic scattering of 6,9-Mev protons by Cr isotopes, 17: 17266
PUECHL, K. H., Prog. rpt. on Pu fuels, 10–12/62, 17: 16524 (NUMEC-P-103)
PUFF, Heinz, Photoelectron emission by metals. I and II., 17: 16797 (UCRL-Trans-907(L))
PUGACZ, M. A., Neutron irradiation effects in A-286, Hastelloy X and René 41, 17: 16745 (TID-18150)
PUGH, S. F., Plutonium fuels for power reactors, 17: 16572
PUGH, Sento, European research center for radiation biology, 17: 15535 (UCRL-Trans-904)
PUMMERY, F. C. W., Cesium separation by AMP process. IV., 17: 16139 (AERE-R-4245)
PUPP, W., Sorption effects on measurements under ultra-high vacuum, 17: 16184 (AERE-Trans-920)
PUSCHEL, W., Study of 224 r^{+} decays, 17: 17007
PUSHNITSINA, A. D., Effects of γ irradiation on hemopoiesis, 17: 15742
PUTMAN, John Laban, Gamma ray thickness gages, 17: 16407
PUTZ, R. R., Gamma intensity in presence of shielding, 17: 17393 (NP-12611)
PYATNITSKII, I. V., Complex compounds of metals with hydroxy acids, 17: 15918
PYKA, Manfred R., Absorption times of negative pions in H, 17: 17230
PYSH, E. S., Polarographic oxidation potentials of aromatic compounds, 17: 16033 (TID-18149)

Q

QUARENI, G., Study of 224 r^{+} decays, 17: 17007
QUARENI-VIGNUDELLI, A., Study of 224 r^{+} decays, 17: 17007
QUERZOLI, R., Quantum numbers of the η particle, 17: 16994
QUIGLEY, J. A., Radiation: industry's best understood problem, 17: 16351
QUINCY, R. B., Jr., Inorganic preparations, 17: 15859 (ORNL-3397(p.112-13))
QUINN, E. P., Prog. rpt. on Garigliano reactor, 9–12/62, 17: 17539 (GEAP-4164)
QUINN, E. P., Vibration of fuel rods in parallel flow, 17: 17537 (GEAP-4059)
QUINTILIANI, M., Sensitization of blood red cells to x rays, 17: 15786

R

RACE, George J., Histopathologic study of immunized mice exposed to total-body x irradiation, 17: 15654
RACHMANINOFF, Nikolai, Sarcoma-like tumors of skin following irradiation, 17: 15806
RADICELLA, R., Search for isomers Sr-89m and Sr-91m, 17: 17243
RAEVA, N. V., Responses to adrenaline in dogs recovering from radiation sickness, 17: 15840
RAGAINI, Richard, Low-level applications of solid-state detectors, 17: 16056 (TID-18261(p.73-4))
RAICA, Nicholas, Jr., Prog. rpt. on wholesomeness of irradiated diet, 3–9/62, 17: 16365 (NP-12603)
RAIEVSKI, Victor, Nuclear reactor control, 17: 17589
RAINEY, R. H., Solvent extraction with TBP, 17: 16146 (ORNL-TM-527)
RAITCHEV, Roiko D., Skin reactions after irradiation—radiobiotropism, 17: 15757
RAJAN, M. K. S., Analysis of stress concentrations in thin spherical shells, 17: 16664 (UCRL-13064)
RAKAVY, G., Correlation between spectra and neutrons evaporated, 17: 17162
RAKOVIC, M., Excretion of Na by saliva after irradiation in rats, 17: 15719
RAKOVIC, Miloslav, Influence of x-irradiation on K-42 content in rats, 17: 15687
RAMAGE, Carol M., Survival of uv-irradiated *Shigella sonnei*, 17: 15721
RAMSAK, V., Radiative capture of 14-Mev neutrons in Al-27, 17: 17207
RAMSAY, William, Baryon mass splitting and weak and strong couplings, 17: 17016
RANBY, P. W., Thorium phosphate phosphors, 17: 16684
RANDALL, C. C., Organic moderated fluidized bed reactor experiment, 17: 17428 (WCAP-1635)
RANDALL, Duncon, Hazards evaluation of HWCTR, 17: 17592 (DP-600)
RANDOLPH, P. D., Violating of f-sum rule in liquid Na, 17: 17183
RANNEY, Helen M., Association of radioactive Cr with various components of hemoglobin, 17: 15593
RAPP, Donald, Charge exchange in the protonosphere, 17: 16928
RASMUSSEN, B. V., Solid state processes in irradiated serum albumin, 17: 15772
RATAU, Joseph T., Double-charged pion production in (π^{-},p), 17: 17028
RATLIFF, J. L., Tensile properties of W, 17: 16639 (DMIC-Memo-157)
RAUB, Ernst, Ruthenium–V alloys, 17: 16717
RAUTH, A. M., Energy loss of electrons, 17: 15765
RAY, D. K., Crystalline electric field effects on rare earth ions. I., 17: 15941 (AFCRL-62-945)
RAYNAL, J., Optical model for elastic scattering of deuterons, 17: 17005
RAZ, B. James, Interparticle interactions in even-even nuclei. II., 17: 17214
RAZDAN, H., Asymmetries in Forbush decreases. I., 17: 16925
RAZDAN, H., Asymmetries in Forbush decreases. II., 17: 16926
REAGAN, J. B., Instrumentation for space radiation. I., 17: 16892
REAGAN, J. B., Soft particle detectors, 17: 16897
REBER, Elwood F., Prog. rpt. on wholesomeness of irradiated food, 3–9/62, 17: 16364 (NP-12602)
REDDY, Vasunder, Radiation damage in muscle cell membranes, 17: 15641 (TID-18221)
REDEI, L. B., Limits of error in quantum mechanical calculations, 17: 16852
REDMAN, J. D., Vacuum systems, techniques, and material studies, 17: 17337 (ORNL-3392(p.86-8))
REE, Taikyue, Prog. rpt. on liquid coolants, 1/28/61–1/31/62, 17: 16031 (TID-17275)
REED, J. F., Turbulent mixing of axisymmetric compressible jets, 17: 16177 (SC-4764(RR))
REED, J. H., Prog. rpt. on measurement of capture γ rays from elements, 11/62–1/63, 17: 15943 (ARF-1193-20)
REID, G. R., Cesium electron bombardment ion motor, 17: 16873
REID, K. W., Cobalt spill at NRX, 7/58, 17: 17594 (IOI-158)
REIN, J. E., Prog. rpt. on burnup of nuclear fuels, annual, 1962, 17: 17426 (TID-17385)
REINER, A., Different linked-cluster expansions, 17: 17065
REINHARZ, M., Mass spectrometer of Laboratorie of Géologie et Géochimie

Nucléaires, 17: 16385 (NP-12457)
REINOV, N. M., Superconducting Nb–Zr alloy at 9250 Mc/s, 17: 16722
REMAEV, V. V., Isomeric transitions in even-even nuclei with half life 10^{-4} to 10^{-1} sec, 17: 17147
RENARD, P., Interactions of K^- mesons with nuclei, 17: 17191
RENNER, Karlheinz, Changes to amylose molecules of starch solution after irradiation, 17: 16087
RENOUX, Andre, Charge of small radioactive ions and fixation on aerosols, 17: 16271
REPUCCI, A., Color centers in mixed crystals of alkali halides, 17: 16759
RESCH, G., Corrosion of Fe in O_2-containing condensate, 17: 16599
RESL, J., Synchroscope for studying fast processes, 17: 16461
REVESZ, Laszlo, Radiosensitivity of sublines of a tumor-cell population, 17: 15688
REVIS, V. A., Incorporation of S^{35}-methionine in bone marrow, 17: 15843
REYSSAT, Michel, Perturbations produced by high-altitude thermonuclear explosions, 17: 16272
REZONTOV, V. A., Role of thyroid gland in radiation sickness, 17: 15673
RICARD, Pierre-Jean, Liquid moderator reactors, 17: 17499
RICHARDSON, J. Reginald, High-energy cyclotron to accelerate H^- ions, 17: 17319 (TID-18223)
RICHERT, S., Search for photoproduction of η^0 meson, 17: 16987
RICHMOND, C. R., Retention of I-131 by mammalian species, 17: 15588 (LADC-5209)
RICKARD, W. H., Effects of γ radiation on pinyon pine, 17: 15733
RICKAYZEN, G., Theory of superconductivity (aspects of), 17: 17076
RIDER, B. F., Prog. rpt. on burnup of nuclear fuels, annual, 1962, 17: 17426 (TID-17385)
RIEDEL, H. J., Isolation of Fr-223 on ultramarine, 17: 16160
RIEDESEL, R. G., Reusable-manned-nuclear orbital carrier, 17: 17613
RIEMAN, William, III, Analytical chemistry of polyphosphates, 17: 15885 (TID-18119)
RIGA, A. J., Distribution of P-32, Ca-45, and Zn-65 in bean, 17: 15551
RILEY, W. C., Beryllium compounds, 17: 16715
RINALD, Donald F., Radioactive fluid handling system, 17: 17526
RINZIVILLO, R., Fission of U, Th, and Bi by 20-Bev protons, 17: 17180
RISCHARD, C. E., Hazards of ionizing radiations, 17: 16337
RIVINGTON, Herbert Lawrence, Production of low-permeability C, 17: 16578
RIZA-ZADE, R. R., Radiation effects on morphological changes in plants, 17: 15749
ROACH, Donald Vincent, Adsorption of K and Cs on W, 17: 16027
ROBERT, Claude, Nuclear magnetic resonance in ferromagnets, 17: 16772 (CEA-2213)
ROBERTS, J., Oxidation in air and CO_2 of various purified graphites, 17: 15966 (NP-tr-958)
ROBERTSHAW, F. C., Neutron irradiation effects in A-286, Hastelloy X and René 41, 17: 16745 (TID-18150)
ROBINS, R. G., Precipitation of U in UO_2, 17: 16693
ROBINSON, Preston, Method of making transistors, 17: 16629
ROBKIN, M. A., Prog. rpt. on Pu recycle, 7–9/62, 17: 16738 (GEAP-4081)
ROBOUCH, B. V., Magnetic field topography in radial-sector accelerators, 17: 17311 (CERN-62-34)
ROBSON, J. M., Cross section for $Ni^{58}(n,\alpha)Fe^{55}$ ground-state transition, 17: 17139
ROCHE, Roland, Reactor support housing for fuel elements, 17: 17504
RODERICK, Thomas H., Selection for radiation resistance in mice, 17: 15680
ROELLIG, H. E., Analysis of nuclear fission products, 17: 15892
ROESSNER, Wolfgang, Leading-in plate for passing cables into reactor vessel, 17: 17512
ROGACHEVA, L. S., Distribution of vitamin B_{12} in rat during acute radiation syndrome, 17: 15836
ROGERS, John D., Magnetic properties of deformed nuclei, 17: 17199
ROGERS, K. C., Field reversal in tenuous plasma, 17: 16790 (TID-18216)
ROGERS, Paul C., Decay of Sc-42m and Ca-42 levels, 17: 17218
ROHAN, P., Effect of nuclear explosion on radio propagation, 17: 15536
ROHRMANN, C. A., Radioisotopic heat sources, 17: 16357 (HW-76323)
ROMANOV, G. A., Magnetic properties of U_3O_8, 17: 16674
ROMNEY, Carl, Seismic detection methods, 17: 16905
RON, A., Secondary H isotope effects. I., 17: 15990
RON, Amiram, High-frequency conductivity of fully ionized plasma, 17: 17325 (MATT-130)
ROOF, R. B., Jr., Crystal structure of Pu_2Co, 17: 16647 (LADC-5363)
ROOKSBY, H. P., Intermetallic phases in commercial Be, 17: 16691
ROSA, U., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
ROSE, P. H., Hydrogen ion beam from duoplasmatron source, 17: 16833
ROSE, P. H., Measurements in partially ionized air, 17: 16252
ROSENBERG, Leonard, Electromagnetic interactions of neutrinos, 17: 17018
ROSENBLUTH, N. N., Relativistic virial theorem, 17: 16829
ROSENFELD, Arthur H., Eightfold-way assignments for Y_1^*, 17: 17043
ROSENFELD, L., Quantization of fields, 17: 16826
ROSINA, M., Structure of the giant resonance, 17: 17160
ROSNER, B., g-Factor of 2.083-Mev 4^+ state of Ce-140, 17: 17194
ROSS, Charles P., Hazards evaluation of HWCTR, 17: 17592 (DP-600)
ROSS, J. R., Recovery of Sc from U solutions, 17: 16164
ROSS, M. A., Effects of irradiated pork diet, 17: 16366 (NP-12604)
ROSS, M. A., Effects of irradiated carrot diet, 17: 16367 (NP-12605)
ROSS, M. A., Effects of irradiated orange diet, 17: 16371 (NP-12609)
ROSSOW, Vernon J., Interaction of waves on liquid metals with magnetic fields, 17: 16784 (NASA-TR-R-161)
ROTHMAN, M. A., Use of magnetically compressed plasmas in stellarator, 17: 17326 (MATT-133)
ROTHMANN, Hans, X-ray spectrum analysis of Ta and Cb, 17: 15900
ROTTER, Ingrid, Deformation of nuclei by rotation, 17: 17134
ROUNDS, Donald E., Radioprotective agents, 17: 15803 (SAM-TDR-62-85)
ROUS, W. C., Evaluation of Zr–Nb cladding for BWR, 17: 16586 (GEAP-4098)
ROUTH, J. I., Radioiodine uptake studies in newborn infants, 17: 15600
ROWE, G. H., Creep-rupture behavior for type 316 stainless steel, 17: 16682
ROWE, P. C., Polarization in proton–C scattering at 28 Mev, 17: 17198
ROWLAND, J. H., Instrumentation for space radiation. II., 17: 16893
ROZENTAL, O. M., Small-size pulse-height analyzer, 17: 16465
ROZHDESTVENSKAYA, Z. B., Amperometric determination of U, 17: 15922
RUBINA, L. S., Bibliography of IGY literature published in Russian in 1960, 17: 16266 (NASA-TT-F-109)
RUBNITSKAYA, A. Yu., Antibody formation process during irradiation, 17: 15647 (JPRS-18020)
RUDDY, Francis H., Analytical chemistry of alkaline earths, 17: 16055 (TID-18261(p.71-2))
RUDERMAN, Malvin A., Measurement of electric charge renormalization, 17: 16958 (UCRL-10336)
RUDNICKI, T., Biological effect of 30-Mev electrons, 17: 15677
RUDNICKI, Tadeusz, Biological effects of 30-Mev electrons, 17: 15648
RUEHL, Werner, Pair production on protons at high energies, 17: 16961
RUGH, R., Behavior of rats resulting from fetal x irradiation, 17: 15655
RUIZ, C. P., Isotopic analysis of UO_2 fuel irradiated in VBWR, 17: 16739 (GEAP-4107)
RUNNALLS, O. J. C., Plutonium studies at Chalk River, 17: 16556
RUNNALLS, O. J. C., Preparation of Pu–Al and other Pu alloys, 17: 16568
RUSCHE, Ben C., Hazards evaluation of HWCTR, 17: 17592 (DP-600)
RUST, Francis G., Low-temperature still for separation of H isotopes, 17: 16490 (DP-732)
RUTHERFORD, Henry A., [Effects of radiation on] textiles, 17: 16104
RUTLEDGE, A. R., Coefficients for angular correlation in nuclear bombardment, 17: 17104 (CRP-615(Rev.))
RYAZANOV, M. I., Decay of ultrahigh-energy particles in condensed matter, 17: 17056
RYBAKOV, V. N., Secondary reactions of d and t capture, 17: 17116 (JINR-P-1157)
RYBARSKA, B., Calculations of strongly deformed element properties using superfluid nuclear model, 17: 17113 (JINR-E-1154)
RYDE, Hans, Electron capture decay of Er-165, 17: 17136
RYNDIN, R. M., Determination of K^0-meson spin, 17: 17055
RYSKIN, A. Ya., Luminescence spectrum of $CaF_2:Sm^{++}$ and $SrF_2:Sm^{++}$ crystals, 17: 16011

S

SABINE, T. M., Calculation of crystal and counter settings for collection of

crystallographic data, 17: 15936 (AAEC/TM/179)
SABINE, T. M., Crystallographic structure factor program for IBM 1620 computer, 17: 16767 (AAEC/TM-180)
SACCA, Giuseppe, Studies on houseflies sterilized with x rays, 17: 15751
SACK, Henri, Regenerating alkyl-amide catalyzers used for enrichment of D, 17: 16500
SADAGOPAN, Varadachari, Structure of WC by neutron and x-ray diffraction, 17: 16708
SADARANGANI, S. H., Estimation of T by gas-phase counting, 17: 15871 (AEET/HP/TM-10)
SADOKHIN, I. P., Inelastic neutron scattering on Fe, 17: 17473
SAETTA-MENICHELLA, E., Calculations of (n,α) cross sections at 14 Mev, 17: 17206
SAFAROV, S. A., Radiation stability of heterocyclic compounds, 17: 16063
SAHLER, O. D., Irradiation and marrow infusion in leukemia, 17: 15546
SAIKKONEN, Jouko, Reactivation of erythropoiesis by Co after radiation injury, 17: 15810
ST. LEGER-BARTER, G., Tory II-C instrumentation, 17: 16881
SAKAI, M., Note on 1^- state in vibrational region, 17: 17201
SAKKA, Masatoshi, Leukemia and ionizing radiation in Japan, 17: 15829
SALAMANNA, S., Activity of reticulo-endothelial system investigated with radio-Au colloids, 17: 15715
SALAMANNA, S., Electrophoretic patterns of Au-198 injected into rabbit, 17: 15608
SALAMANNA, S., Study of granulopoietic capacity of reticulo-endothelial system by radio-Au, 17: 15607
SALEH, F. M., Coincidence study of $K^{38}(n,p\gamma)Ar^{38}$, 17: 17196
SALMON, Merlyn L., X-ray spectrographic analysis of minerals, 17: 15893
SALPETER, E. E., Density fluctuations in nonequilibrium plasma, 17: 17350
SAMAIN, A., Behavior of plasma produced by button-type source, 17: 17360
SAMBROOK, D. K., Fractionation and dose-time relationships, 17: 15659
SAMPSON, J. B., Activation of Th-232 resonance captures in prototype HTGR, 17: 17107 (GA-3069)
SAMSAHL, K., Anion-exchange of radioactive trace elements in H_2SO_4, 17: 16138 (AE-103)
SAMSONOV, G. V., Resistivity of hexaborides of rare-earth metals, 17: 16726
SAMUEL, Claude, Stabilizing system for reactors, 17: 17590
SAMUELS, Melvin, Radiation-sensitizing agents in squamous cell carcinoma, 17: 15669
SANDERSON, J., Beta-decay matrix elements in Sb-122, 17: 17215
SANIEWSKA, T., Interactions of protons with heavy nuclei, 17: 17161
SANTHA, A., Early radiation reaction of digestive system. II., 17: 15683
SARABHAI, Vikram, Nonuniformity of solar wind velocity, 17: 16913
SARAVACOS, G. D., Lethal doses of radiation for fruit spoilage microorganisms, 17: 16374
SARRE, H., Hypertonia, nephritis, and nephrofibrosis after kidney irradiation, 17: 15709
SATSUNKEVICH, I. S., Determination of electron form factor, 17: 17053
SATTLER, Allan Richard, Decay of Sr-85 and Sr-89, 17: 17298
SAUBERLICH, Howerde E., Prog. rpt. on wholesomeness of irradiated diet, 3–9/62, 17: 16365 (NP-12603)
SAUNIER, N., Alpha particles from reaction Li-6 + Li-7, 17: 17197
SAUR, E., Application of supraconductivity, 17: 16705
SAVERY, C. W., Prog. rpt. on carbides for thermionic space reactors, 11/30/62, 17: 16516 (GA-3866)
SAVICH, A. V., Influence of peroxides on radiochemical transformations of purines, 17: 15779
SAVITSKII (SAVITSKY), E. M., Influence of temperature on metals and alloys, 17: 16725
SAVVIN, S. B., Determination of Th in presence of rare earths, 17: 15926
SAXENA, M. C., Precipitation of Na and NH_4 diuranate, 17: 15999
SAXENA, R. S., Amperometric determination of Ce(III) as molybdate, 17: 15907
SAXENA, Ram Sahai, Titrations of trivalent Ce with alkali molybdate, 17: 15997
SCAIFE, J. F., Changes in pyknotic irradiated thymocytes, 17: 15667
SCANLON, J. P., Scattering of neutrons by U from 18 to 120 Mev, 17: 17159
SCARASCIA, G. T., Mutations in *durum* wheat induced by radiations, 17: 15731
SCARF, F. L., Dispersion function for a plasma, 17: 17357
SCHABERT, Hans-Peter, Device for monitoring insulating tube in reactor pressure tube, 17: 17513
SCHAPIRA, J. P., Angular distributions in (d,α) reactions, 17: 17171
SCHARFF-GOLDHABER, G., Decay schemes in Os–Ir region. III., 17: 17213
SCHARMANN, A., Interaction of radiation and matter, 17: 17156
SCHATVET, J., NORA—zero-power experimental reactor facility, 17: 17595 (KR-41)
SCHAURER, Gustav, Increasing D content of H, 17: 16494
SCHEFFEL, Rudolf, Apparatus for producing difference in pressure between interconnected gas chambers, 17: 16215
SCHEPERS, G. W. H., Neoplasia experimentally induced by Be compounds, 17: 15835
SCHERBATSKOY, Serge A., Apparatus for deep-well logging, 17: 16412
SCHERBATSKOY, Serge A., Epithermal neutron detection, 17: 16410
SCHERBATSKOY, Serge A., Radiation detector, 17: 16413
SCHIFF, L. I., Application of variation method to field quantization, 17: 16853
SCHIMIZU, Taiji, Effect of radiation on protein metabolism, 17: 15750
SCHINKE, D., Optical absorption of color centers in LiF containing Mg, 17: 15960 (TID-18146)
SCHLEA, Carl S., Pilot plant for processing irradiated nuclear fuel, 17: 16140 (DP-757)
SCHLUDI, H. N., Influence of H_2O on multiplication factor of D_2O-moderated reactor, 17: 17432
SCHLUDI, H. N., Manufacture of fuel elements, 17: 16627
SCHMIDT, G., Cherenkov-like radiation by plasma oscillations, 17: 17341 (TID-18225)
SCHMIDT, G., Field reversal in tenuous plasma, 17: 16790 (TID-18216)
SCHMIDT, George, Plasma rotation produced by electrodeless plasma gun, 17: 17361
SCHMIDT, R. A., Design of MWe boiling water—separate superheat reactor, 17: 17536 (GEAP-4057)
SCHNEIDER, Helga, X-ray spectrum analysis of Ta and Cb, 17: 15900
SCHNEIDER, W., Shielded sample changer for coincidence measurements, 17: 16445
SCHOEN, D., Cause and significance of irradiation leukopenia, 17: 15819
SCHOFIELD, P., Neutron scattering law and neutron thermalization, 17: 17088 (BNL-770)
SCHOFIELD, R., Bone-marrow treatment of irradiated rhesus monkeys, 17: 15821
SCHOLES, G., Effects of radiations on nucleic acids, 17: 15771
SCHONFELD, F. W., Dilatometry and thermal analysis of Pu metal, 17: 16561
SCHONFELD, F. W., Plutonium phase diagrams published by the Russians, 17: 16567
SCHOTTE, D., Decay scheme for β transition Ag-110m → Cd-110, 17: 17251
SCHRAM, Pieter, Comments on "kinetic equations for plasmas", 17: 17367
SCHRAMM, K. H., Microwave density of plasma, 17: 17371
SCHROEDER, Heinrich J., Separation of natural radionuclides, 17: 16159
SCHUELER, C., Magnetic and quadrupole moments of 8.42-kev state of Tm-169, 17: 17252
SCHULT, O. W. B., Construction of bent-crystal γ spectrometer, 17: 16447
SCHULT, O. W. B., Equipment of bent-crystal γ spectrometer, 17: 16448
SCHULT, O. W. B., Measuring the mosiac spread width of crystals, 17: 16811
SCHULTZ, Vincent, Bibliography on radionuclides and ionizing radiation in ornithology, 17: 15635 (TID-17762)
SCHULZ, G. J., Prog. rpt. on vacuum techniques, annual, 1962, 17: 16181 (TID-18283)
SCHUNE-BOISBLE, Denise, Method for study of multiple scattering, 17: 16815
SCHUSKE, C. L., Criticality measurements on Pu metal, 17: 16941 (RFP-63)
SCHWAAB, Paul, Precipitation processes in Ni–Cr alloy, 17: 16718
SCHWARTZ, Charles M., Determination of thermal expansion by x-ray diffraction, 17: 16668
SCHWARTZ, Henry P., Prog. rpt. on effects of x rays on DNA acids, 5/62–1/63, 17: 15636 (TID-18061)
SCHWARZSCHILD, A., Lifetimes of 4+ and 2+ states in rotational nuclei,

17: 17219
SCHWEIGERT, B. S., Radiation pasteurization, 17: 15583
SCHWEITZER, G. E., Proceedings of AMU-ANL summer study program, 6/19–7/14/61, 17: 17403 (ANL-6640)
SCHWINGER, Julian, Commutation relations and conservation laws, 17: 16851
SCHWINGER, Julian, Non-Abelian gauge fields. Lorentz gauge formulation, 17: 16513
SCHWINGHAMER, E. A., Studies induced variation in the rhizobia. III., 17: 15649
SCIBONA, G., Extraction of Pu(IV) nitrate with tertiary amine nitrates, 17: 16154
SCIBONA, G., Extraction of U(VI) from HNO_3 solutions, 17: 16155
SCIESINSKI, Jan, Automatic steering of neutron spectrometer, 17: 16454
SCIUTI, S., Gamma rays from thermal neutron capture in Ho, Tm, and Lu–I, 17: 17181
SEABORG, Glenn T., Discovery of Pu in the cyclotron, 17: 16551
SEABORG, Glenn T., Fission induced by heavy ions in Au and Bi, 17: 17225
SEABORG, Glenn T., Synthetic Elements. III., 17: 16085
SEDDON J. Carl, Model of quiet ionosphere, 17: 16284
SEDYKH, T. S., Chlorination of loparite concentrate, 17: 16024
SEGEL, A. W. L., Photoelastic study of metallic seals, 17: 16170 (AECL-1662)
SEGHEZZI, Hans-Dieter, Oxygen adsorption on Ta layers, 17: 16719
SEGUIN, Heinz, Method and means for assaying fuel elements, 17: 16261
SEIFERT, Juergen, Changes to amylose molecules of starch solution after irradiation, 17: 16087
SEKAMOVA, E. N., Luminescence of normal and irradiated liver tissue, 17: 15736
SEKI, Jisuke, Analytical application of fluoric ion. III., 17: 16161
SEKI, Jisuke, Analytical application of fluoric ion. IV., 17: 16162
SEKI, Jisuke, Analytical application of fluoric ion. V., 17: 16163
SELEBORG, M., Bibliography on extraction of U, 17: 16147 (VDIT-68)
SELEBORG, Madeleine, Bibliography on separation of U(VI) from aqueous solutions, 17: 16148 (VDIT-70)
SELINOV, I. P., Periodic system of isotopes. Supplement to isotope table, 17: 17287
SEMENENKO, K. A., Effect of phosphomolybdate on determination of Nb and Ta, 17: 15930
SEN GUPTA, A. K., E2/M1 mixing ratios for γ transitions in even nuclei, 17: 17205
SENTURK, S., Neutron-scattering estimation of cement content of concrete, 17: 15901
SEREBRENNIKOV, V. V., Determination of Nd by radiometric titration, 17: 15925
SEROV, V. I., Packing of excitation levels of light nuclei near thresholds, 17: 17099
SERPAN, C. Z., Jr., Physical peculiarities of Pu, 17: 16669
SEVERIN, P. J., Cathode fall region in d-c glow discharge, 17: 16854
SEWARD, G. R., Safety precautions in dental radiography, 17: 16349
SGARLATA, F., Program for calculating roots of n degree polynomial, 17: 16425 (ISS-62/11)
SHAFER, Janice B., Spin and parity of Y_1^* resonance, 17: 17040
SHAFRANOVA, M. G., Elastic p-p scattering at 8.35 Bev, 17: 16950 (JINR-P-1135)
SHAIR, F. H., Interaction of magnetic field with fluid in couette flow, 17: 17339 (R63SD16)
SHAKHIDZANYAN, L. G., Contamination and distribution of Ce in animals, 17: 16304
SHALAEV, A. M., Effects of γ radiation on deformed metals, 17: 16541
SHALAMOV, Yu. Yu., Data on three-pion interaction, 17: 17050
SHALEIKO, M. A., Small-size pulse-height analyzer, 17: 16465
SHAL'NOV, M. I., Influence of peroxides on radiochemical transformations of purines, 17: 15779
SHAMRAI, F. I., Data on system Ti–B–Cr, 17: 16711
SHAMRAI, F. I., Phase equilibrium and properties of W–Nb–Si, 17: 16710
SHAPIRO, Edward M., Carcinogenic effect of exposure to grenz ray, 17: 15823
SHAPIRO, G. A., Effect of additions of oxides on Mg–Mn ferrites, 17: 16019
SHAPIRO, I. M., Analysis of intestinal epithelium in x irradiation, 17: 15746
SHAPIRO, I. S., Dispersion theory of direct nuclear reactions, 17: 17304
SHAPIRO, I. S., Mechanism of π^--meson capture by light nuclei, 17: 17273
SHARKEY, William H., Diamines having two deuterium atoms, 17: 16039
SHARPATYI, V. A., Radiation stability of heterocyclic compounds, 17: 16063
SHASTOVA, A. K., Induced emf and dielectric strength in x-irradiated PVC, 17: 16761
SHASTRI, N. K., Kinetics of the reduction of Np(V) with iodide ion, 17: 16003
SHATALOV, A. Ya., Anodic oxidation of Nb, 17: 16675
SHAW, D. F., Proton-deuteron interactions at 77 Mev, 17: 17009
SHAW, David M., Detection of nuclear explosions, 17: 16904
SHAW, E. N., Intensive development in British nuclear instrumentation, 17: 16388
SHEA, K. G., Low-dose radiation processing of food, 17: 15558
SHEKHTER, V. M., Weak coupling motion of Regge poles, 17: 17277
SHEPHERD, L. R., Irradiation experiments in reactor development, 17: 17437
SHEPSHELEVICH, L. L., Distribution of vitamin B_{12} in rat during acute radiation syndrome, 17: 15836
SHERBY, D., Influence of temperature on metals and alloys, 17: 16725
SHERMAN, R. H., T_{58}, He^3 temperature scale. I., 17: 15952 (LADC-5711)
SHERWIN, Ruth W., Effects of depilatory x irradiation on hair growth in mice, 17: 15822
SHETOPEROV, V. Ya., Ionization bursts and spectrum of nuclear-active particles at mountain heights, 17: 16934
SHEVCHIK, V. I., Oscillation effects in super-high frequency electron flux, 17: 17388
SHEWCHUCK, Sergey, Photoelectron emission by metals. I and II, 17: 16797 (UCRL-Trans-907(L))
SHEWMAKER, James E., Irradiated petroleum resins, 17: 16116
SHIBATA, Kyoko, Biological radiation protection. XLVII., 17: 15754
SHIELDS, L. M., Effects of γ radiation on pinyon pine, 17: 15733
SHIGORIN, D. N., EPR spectra of γ-irradiated multibond compounds, 17: 16067
SHIKHOV, S. B., Construction of multigroup resonance constants, 17: 17470
SHIKOV, S. B., Two-group calculations for intermediate-thermal reactors, 17: 17462
SHIMAMOTO, Susumu, Helical instability in positive column in magnetic field, 17: 17352
SHIMAZAKI, T. T., Pyrolytic capsule fouling test, 17: 17423 (NAA-SR-Memo-8088)
SHIN, Ernest E. H., Quantization of elementary particle masses, 17: 17044
SHINOHARA, Kenichi, Flow temperature and crystallinity of copolymers produced by radiation, 17: 16081
SHINOHARA, Kenichi, Irradiation of polyvinyl chloride, 17: 16082
SHIPLEY, E. D., Optimum energy for plasma confinement, 17: 17365
SHIROKOV, Yu. M., Microcovariance and microcausality in quantum theory, 17: 17400
SHIZUME, Toshio, Mechanics of transport phenomena in gases, 17: 16822
SHOBER, Frederic R., Annealing studies on irradiated type 347 stainless steel, 17: 16733 (BMI-1621)
SHODA, Katsufusa, Photoprotons from S-32, 17: 17155
SHUBNYI, Yu. K., Lifetime of 0.845-Mev level in Fe-56, 17: 17265
SHUCK, A. B., Fabrication of EBR-II Core I fuel elements, 17: 16602 (ANL-6276)
SHUCK, A. B., Facility 350 He–atmosphere system, 17: 16171 (ANL-6489)
SHUKLA, P. G., Spectrum of heavy primary cosmic radiation, 17: 16932
SHULMAN, R. G., Knight shifts in Nb–Mo alloys, 17: 16709
SHURIN, A. K., Constitution diagram of Fe–C–Hf, 17: 16542
SHUTTLEWORTH, C. J., Model studies of reactor coolant and fuel pin behavior, 17: 17556 (TID-18229)
SHVEDOV, G. H., Oscillation effects in super-high frequency electron flux, 17: 17388
SHVEYKIN, G. P., Carbothermic reduction of Nb_2O_5, 17: 16530 (JPRS-18277)
SIEGBAHN, Kai, Photoelectron method of determining h/e, 17: 16809
SIERGIEJ, J. M., Prog. rpt. on ribbed Be tubing extrusion, final, 5/61, 17: 16607 (NMI-4950)
SILIN, I. N., Conformal mapping in scattering of high-energy particles,

17: 17054
SILTANEN, O., 992 Kev $Al^{27}(p,\gamma)Si^{28}$ resonance, 17: 17200
Silva, P. R. Paula E
see Paula E Silva, P. R.
SILVER, E. G., Reactivity effects of displacements in pool-type reactor, 17: 16322 (ORNL-3401(p.3-4))
SILVERBERG, L., Effect of pairing correlations on β decays, 17: 17182
SILVERMAN, A., Search for photoproduction of η^0 meson, 17: 16987
SILVESTER, J. A., Fractionated x-ray treatment of skin of pigs, 17: 15662
SILVESTRINI, V., Quantum numbers of the η particle, 17: 16994
SIL'VESTROVA, I. M., Effect of γ radiation on piezoelectric and elastic properties of triglycinsulfate crystals, 17: 16860
SIMANOV, Yu. P., Rhombic modification of BeF_2, 17: 16673
SIME, J. M., Oxidation of aldehydes with Br and D isotope effects, 17: 16037
SIMIC, M. M., Nucleic acids after uv irradiation, 17: 15777
SIMMONS, J. E., Polarization in neutron-proton scattering at 23.1 Mev, 17: 17024
SIMON, Albert, Instability of partially ionized plasma in crossed fields, 17: 17356
SIMON, H. W., Energy dependence of proton damage in Si, 17: 16758
SIMON, Johannes, Pocket dosimeter with compass, 17: 16431 (AEC-tr-5558)
SIMONS, E. M., Reactor Materials, Vol. 6, No. 1, 17: 17442
SIMONS, L., 992 Kev $Al^{27}(p,\gamma)Si^{28}$ resonance, 17: 17200
SINGH, B. B., Radiation-induced free radicals and identification, 17: 15763
SINGLETON, J. H., Prog. rpt. on vacuum techniques, annual, 1962, 17: 16181 (TID-18283)
SINIZER, D. I., Relationship of carburizing potential to operating temperature limitations in SRE, 17: 17597 (NAA-SR-Memo-7804)
SISMAN, Oscar, [Effects of radiation on] polymers, 17: 16098
SISMAN, Oscar, [Effects of radiation on] plastics, 17: 16099
SITENKO, A. G., Polarization in direct nuclear reactions, 17: 17244
SKALKA, M., Effect of radiation on deoxyribonucleoproteins, 17: 15789
SKARSGARD, H. M., Theory of plasma oscillations in formation of runaway electron stream, 17: 17344
SKIDMORE, M. R., Vacuum arc research, 17: 17333 (ORNL-3392(p.47-8))
SLASTNIKOVA, L. F., Diffusion of Fe in Fe–Hf alloys, 17: 16546
SLICK, William C., Radioprotective agents, 17: 15803 (SAM-TDR-62-85)
SLIEMERS, Francis A., Radiolysis of the isomeric poly(butyl methacrylates), 17: 16070
SLINN, W. G., Cross section for $Ni^{58}(n,\alpha)Fe^{55}$ ground-state transition, 17: 17139
SLIV, L. A., Level with spin I = 16 in Po-212, 17: 17271
SLIV, L. A., Residual pair forces in O-18 and F-18, 17: 17275
SLOTKIN, Marvin B., Single dose x irradiation of lung and posterior mediastinum. III., 17: 15830
SLOTOVA, Jana, Effect of DNA on chromosomal aberrations in bone marrow, 17: 15788
SMAKULA, A., Color centers in mixed crystals of alkali halides, 17: 16759
SMALL, Lawrence, Radioactivity in large marine plankton, 17: 15609
SMALLEY, W. R., Effects of irradiation on pressure tube material, 17: 16734 (CVNA-159)
SMET, Pierre, Determination of eigen-energies and functions. II., 17: 17396
SMIBERT, R. M., Prog. rpt. on effects of irradiated diet, 9/15/62, 17: 16363 (NP-12600)
SMIRNOV, B. M., Slowing down of protons and μ^+ mesons in metal, 17: 17268
SMIRNOV, K. V., Disturbance and restoration of G-I tract during radiation sickness, 17: 15838
SMIRNOVA, I. B., Analysis of intestinal epithelium in x irradiation, 17: 15746
SMIRNOVA, V. I., EPR spectra of γ-irradiated multibond compounds, 17: 16067
SMIT, C., Fluctuations in counting rate of photomultipliers, 17: 16456
SMITH, B. C., Quinquevalent compounds of U. III., 17: 15994
SMITH, Cyril Stanley, Plutonium metallurgy at Los Alamos, 1943–45, 17: 16554
SMITH, D. F., Criticality measurements on Pu metal, 17: 16941 (RFP-63)
SMITH, D. R., Analysis of hypertriton by hard-core potentials, 17: 17014
SMITH, D. R., Organic moderated fluidized bed reactor experiment, 17: 17428 (WCAP-1635)
SMITH, Donald V., Radio fluid detector, 17: 16482
SMITH, Ernest, Improvements in reactor fuel elements, 17: 17493
SMITH, Felix T., Collision lifetimes in many-body processes, 17: 17030
SMITH, J. H., Diffusion theory flux peaking at sharp corner, 17: 17092 (TID-16485)
SMITH, J. O., Model studies of reactor coolant and fuel pin behavior, 17: 17556 (TID-18229)
SMITH, Lamar M. C., Jr., Radiation injury to rectum and sigmoid colon, 17: 15807
SMITH, P. B., Nuclear reactions. II., 17: 17281
SMITH, Philip B., Radiative decay of aligned nuclei, 17: 17286
SMITH, R. V., Instrumentation for space radiation. I., 17: 16892
SMITH, R. V., Instrumentation for space radiation. II., 17: 16893
SMITH, Richard J., Bibliography on peaceful uses of nuclear explosives, 17: 15534 (TID-3522(Rev.6))
SMITH, Stewart W., Generation of seismic waves by underground explosions and collapse of cavities, 17: 16287
SMITS, F. M., Degradation of solar cells under Van Allen radiation, 17: 16884
SMURTHWAITE, John William, Apparatus for vacuum melting and casting metals, 17: 16579
SMY, P. R., Experiments with moving magnetized plasma, 17: 17345
SNAVERLY, William Henry, Jr., Polymerization of vinyl fluoride, 17: 16113
SNIEGOCKI, S., Mass of the muonic neutrino, 17: 16991
SNOWDEN, D. P., Prog. rpt. on radiation effects on Si solar cells, 12/61–12/62, 17: 16736 (GA-3872)
SOBOLEVA, A. V., Oscillation effects in super-high frequency electron flux, 17: 17388
SOGOMONOVA, G. A., Residual pair forces in O-18 and F-18, 17: 17275
SOKOLOVA, N. V., Morphologic changes in liver relative to irradiation, 17: 15817
SOLNTSEV, V. M., Magnetic properties of U_3O_8, 17: 16674
SOLOV'EV, L. D., Photoproduction amplitude from dispersion relations, 17: 17274
SOLOV'EV, L. S., Stability of cylindrical plasma jet in magnetic field, 17: 17349
SOLOV'EV, V. G., Calculations of strongly deformed element properties using superfluid nuclear model, 17: 17113 (JINR-E-1154)
SOLOV'EV, L. D., Infrared singularities in electron-phonon scattering, 17: 16997
SOLOV'EV, V. G., Effect of superconducting pairing correlations on nuclear properties, 17: 17307
SOLOWAY, A. H., Boron compounds for neutron capture therapy. I., 17: 15575
SOLTYSIK, Edward A., Polarization of light emitted by He atoms, 17: 16842
SOMAN, S. D., Estimation of T by gas-phase counting, 17: 15871 (AEET/HP/TM-10)
SOMERVILLE, Graham F., Downflow boiling of n-butanol, 17: 16234 (UCRL-10527)
SOMMER, Arno W., Determining radioactivity in feces, 17: 15894
SONETT, C. P., Distant geomagnetic field. III., 17: 16280
SONETT, C. P., Distant geomagnetic field. IV., 17: 16281
SONETT, C. P., Distant geomagnetic field. II., 17: 16389
SONGINA, O. A., Amperometric determination of U, 17: 15922
SONNENBLICK, B. P., Oxidative phosphorylation in rat liver mitochondria after irradiation, 17: 15570
SOSI, R., Studies on infiltrative interstices of neoplastic malignancies, 17: 15714
SOSKA, J., DNA synthesis after irradiation, 17: 15782
SOSKA, J., Effect of radiation on deoxyribonucleoproteins, 17: 15789
SOSNOVSKAYA, L. I., Ratio ZrO_2/HfO_2 in zircons, 17: 16275
SOUPART, P., Plasma levels after x-ray irradiation, 17: 15784
SOWERBY, D. B., Exchange of Cl-36 of Group III chlorides with nitrosyl and phosphoryl chlorides, 17: 15996
SPALDING, J. F., Breeding characteristics of offspring from irradiated sires, 17: 15629 (LADC-5278)
SPALDING, J. F., Radioresistance in offspring from irradiated parentage, 17: 15630 (LADC-5401)
SPARROW, A. H., Cumulative radiation damage in oak trees, 17: 15734
SPARROW, E. M., Turbulent boundary-layer flow longitudinal to circular cylinder, 17: 16242

SPEAKMAN, Frank Peter, Improvements in gas analysis apparatus, 17: 16396
SPECTOR, Richard M., Shell-model investigation of RaE β decay, 17: 17166
SPEDDING, Frank H., Rare earths, 17: 15985
SPEISER, R. C., Cesium electron bombardment ion motor, 17: 16873
SPEKTOR, A. Ts., Constitution diagram of Fe–Zr alloys, 17: 16544
SPEKTOR, A. Ts., Constitution diagram of $ZrCr_2$–$ZrFe_2$ alloys, 17: 16545
SPENCER, Dwain F., Interstellar travel, 17: 17603 (JPL-TR-32-233)
SPERBER, Daniel, Fission barrier for liquid drop nuclei, 17: 17241
SPEYER, Edward M., Radiation measuring apparatus, 17: 16488
SPHAR, C. D., Isotopic content of irradiated UO_2 fuel rods, 17: 17574 (WAPD-T-1461)
SPILLMANN, Hans-Heinrich, Fuel assembly arrangement of heterogeneous power nuclear reactor, 17: 17588
SPITSYN, V. I., Model for extraction of Hf and Zr with TBP, 17: 16165
SPITSYN, V. I., New problems in radiochemistry, 17: 16091
SPITSYN, V. I., Optimum conditions in extraction of Hf with TBP, 17: 16166
SPITSYN, Vikt. I., Effect of radioactive emission from Na_2WO_4 and Na_2SO_4 on phase transformations, 17: 16066
SPITZER, Daniel Miller, Jr., Energy losses in the ultracentrifuge, 17: 16197
SPITZER, Lyman, Jr., Physics of fully ionized gases, 17: 17386
SPREITER, John R., Boundary of geomagnetic field in steady solar wind, 17: 16291
SPRING, E., 992 Kev $Al^{27}(p,\gamma)Si^{28}$ resonance, 17: 17200
SPRUCH, Larry, Minimum principle for single-channel scattering, 17: 17029
SRAIER, V., Countercurrent extraction in mixer-settler. II., 17: 16151
STAIRS, G. R., Gamma irradiation of pitch pine-oak forest, 17: 15730
STAKER, William P., Radiation flowmeter, 17: 16405
STAMIRES, Dennis N., Electron paramagnetic resonance in molecular transfer complexes, 17: 16785 (NYO-3062)
STANFORD, Russell E. L., Fluid-fueled fast reactor concept, 17: 16575
STANGHELLINI, A., Pion-pion interactions, 17: 16979
STANKEVICS, J. O., Measurements in partially ionized air, 17: 16252
STARITZKY, E., Compounds of divalent lanthanides, 17: 15950 (LADC-5566)
STASCHKOW, A. M., Pecularities of radiation injuries and protection of intact and sympathectomized animals, 17: 15844
STASHKOV, A. M., Prophylaxis of radiation damage in animals, 17: 15841
STEELE, Arthur J., Vehicle design considerations, 17: 17612
STEELE, Edgar L., Prog. rpt. on computer coupled automatic activation analysis and remote lunar analysis, 11/62–2/63, 17: 15888 (TID-18257)
STEELE, L. E., How neutron exposure alters reactor steels, 17: 16752
STEENBECK, Max, Apparatus for producing difference in pressure between interconnected gas chambers, 17: 16215
STEFANI, D. V., Bone marrow chimeras of guinea pigs, 17: 15839
STEFFENSEN, Dale M., Radiation effects on maize, 17: 15626 (BNL-6027)
STEFFENSEN, Dale M., Sensitivity of maize chromosomes to x rays, 17: 15650
STEHLE, Heinz, Method and means for assaying fuel elements, 17: 16261
STEIN, Edward E., Space propulsion component research, 17: 16195
STEIN, William Earl, Time required for nuclear fission, 17: 17299
STEINDLER, M. J., Decomposition of PuF_6 by radiation, 17: 16045 (TID-18184)
STEINER, B., Continuous measurement of radioactive fluids, 17: 16185
STEINER, L. F., Progress of fruit-fly control by irradiation, 17: 15560
STEINKAMP, Ruth C., Treatment of chronic lymphocytic leukemia, 17: 15697
STEINMETZ, H., Prog. rpt. on determination of contaminants in Na, 1–3/61, 17: 15878 (NDA-2154-5)
STEINMETZ, H., Prog. rpt. on continuous meter for O in Na, 9–12/62, 17: 15889 (UNC-5050)
STEPHENS, K. G., Transfer of Jason, 17: 17602
STEPHENSON, Dwight L., Measurement problems encountered in nuclear rocket environment, 17: 16384 (LADC-5679)
STERN, Babette E., Dose-time relationships in radiotherapy, 17: 15658
STERN, T. W., Evaluating discordant Pb-isotope ages, 17: 16308
STERNGLASS, E. J., MHD power generation and application, 17: 16188
STERNHEIM, Morton M., Corrections to hfs in hydrogenic atoms, 17: 16848
STEVENS, H. H., Jr., Loading control of driver elements (AETR critical experiment fuel), 17: 17598 (TID-18121)
STEWART, J. R., Creep-rupture behavior for type 316 stainless steel, 17: 16682
STEWART, Peter, Radiation damage in muscle cell membranes, 17: 15641 (TID-18221)
STIEFF, L. R., Evaluating discordant Pb-isotope ages, 17: 16308
STIERLI, F., Irradiation capsules for Dragon fuel elements, 17: 16755
STIERLIN, U., Scattering of 8-Bev μ mesons on electrons, 17: 17017
STIL'BANS, L. S., Influence of atomic admixtures on thermal conductivity in crystalline lattice, 17: 15967 (SCL-T-468)
STINCHCOMBE, R. A., Generation of Te aerosols and filtration, 17: 15939 (AERE-M-1130)
STINCHCOMBE, R. A., Removal of I vapor from air with Cu, 17: 16008
STIRPE, F., Ascorbic acid synthesis in rat-liver extracts, 17: 15656
STOCKDALE, James Thomas, Fuel elements for nuclear reactors, 17: 17525
STONE, John A., Mössbauer effect in Dy-161, 17: 17130 (UCRL-10630)
STONE, W. H., Loss of tolerance following irradiation, 17: 15761
STONEHOUSE, A. J., Prog. rpt. on high-temperature intermetallic compounds, annual, 1961, 17: 16637 (BBC-115)
STONEHOUSE, Bernard Hugh, Improvements in fuel element arrangements, 17: 17483
STOOPS, Robert F., Prog. rpt. on U interstitial phases, 12/62, 17: 16522 (NCSC-2663-10)
STORIZHKO, V. E., Elastic scattering of protons by Mg-24, 17: 17261
STORVIK, Paul, Prog. rpt. on mechanical properties of Nb, 7–9/62, 17: 16652 (NP-12633)
STORVIK, Paul, Prog. rpt. on mechanical properties of Nb, 1–3/62, 17: 16653 (NP-12634)
STRAIN, William H., Strontium-90 in hair, 17: 15612
STRANG, V. G., Breeding characteristics of offspring from irradiated sires, 17: 15629 (LADC-5278)
STRANG, V. G., Radioresistance in offspring from irradiated parentage, 17: 15630 (LADC-5401)
STRAUSS, Michael G., Multichannel pulse-height analyzer, 17: 16428 (TID-18153)
STRAWBRIDGE, L. E., Organic moderated fluidized bed reactor experiment, 17: 17428 (WCAP-1635)
STREHLOW, R. A., Vacuum systems, techniques, and material studies, 17: 17337 (ORNL-3392(p.86-8))
STRELTSOV, V. N., γ Production in interaction of π^- mesons with nuclei, 17: 17192
STRELTSOV, V. N., Radiative decays of resonance states, 17: 17119 (JINR-P-1164)
STRENG, A. G., Preparation and some properties of KrF_4, 17: 16021
STRENG, L. V., Preparation and some properties of KrF_4, 17: 16021
STROBEL, Donald H., Prog. rpt. on densitometer for He–graphite or N–graphite flow streams, 8–10/62, 17: 16386 (TID-18162)
STROM, E., Sensitization of blood red cells to x rays, 17: 15786
STROMBERG, Harold, Transition in Yb, 41 kilobar, 17: 16662 (UCRL-10332)
STROMER, P. R., Bibliography on solid state properties of Bi and Te alloys and compounds, 17: 16655 (SB-62-62)
STUART, G. W., Relativistic virial theorem, 17: 16829
STUERMER, W., Measuring pressure of radioactively contaminated medium, 17: 16403
STUMPF, W., Continuous measurement of radioactive fluids, 17: 16185
STUPOCHENKO, E. V., Nonequilibrium distribution of energy in gases, 17: 16864
STURROCK, P. A., Nonlinear theory of plasma oscillations, 17: 17327 (ML-874)
SU, Hung-kuei, Formation of $Zr^{97}Cl_4$ by slowing down of fission fragments, 17: 16065
SU, Hung-kuei, Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
SUCHER, J., Rotational invariance and the S matrix, 17: 16843
SUDA, Hidehiro, Measurements of slow neutrons in Pacific and Indian Oceans, 17: 16933
SUGAHARA, Tsutomu, Genetic effects of low-dose irradiation on mice, 17: 15686
SUGAWARA, Masumi, Elastic scattering of photons. II., 17: 17153
SUGIHARA, T. T., Prog. rpt. on chemistry, annual, 1/31/63, 17: 16046

(TID-18261)
SUGIMURA, Katsuji, Effect of γ rays on *Bacillus anthracis*, 17: 15718
SUIT, Herman D., Radiation-sensitizing agents in squamous cell carcinoma, 17: 15669
SUKHAREVSKII, B. Ya., Polymorphous transformation of ZrO_2, 17: 16750
SUN, Shiou-Chuan, Acid leaching of U from Sourth Dakota lignites, 17: 16153
SUNG, Baik Nung, Photoprotons from S-32, 17: 17155
SURANI, P., Regge poles and fire balls, 17: 16949 (JINR-E-1156)
SUVOROV, A. P., Inelastic neutron scattering on Fe, 17: 17473
SUZUKI, Kazuo, Neutron diffraction study of κ phase Cu–Mn–Al alloys, 17: 16702
SVECHNIKOV, V. N., Chromium–Nb–Ti alloys, 17: 16543
SVECHNIKOV, V. N., Constitution diagram of Fe–Zr alloys, 17: 16544
SVECHNIKOV, V. N., Constitution diagram of $ZrCr_2$–$ZrFe_2$ alloys, 17: 16545
SVECHNIKOV, V. N., Constitution diagram of Fe–C–Hf, 17: 16542
SVOBODA, Peter, Conductivity and plastic behavior of irradiated Cu and Ag whiskers, 17: 16762
SWEASEY, D., Extraction of lanthanons with alkali metal amalgams. I., 17: 16157
SWIFT, L. M., Earth motion measurements, 17: 16265 (PNE-111F)
SYDORIAK, S. G., T_{λ_2} He^4 temperature scale. I., 17: 15952 (LADC-5711)
SYMONS, M. C. R., Electron-ejection and -trapping in molecular solids, 17: 16751
SZEPKE, R., Decontamination factors for Vistula River drainage area, 17: 15617
SZYBALSKI, W., Molecular radiobiology of human cell lines. III., 17: 15670
SZYMCZAK, R. A., Secondary reactions of d and t capture, 17: 17116 (JINR-P-1157)

T

TAILLET, Joseph, Interpretation of energy conversion phenomenon, 17: 17346
TAKABAYASI, T., Variables of elementary particles and weak interaction symmetry, 17: 16988
TAKADA, Hisao, Neutron diffraction study of κ phase Cu–Mn–Al alloys, 17: 16702
TAKAHASHI, Naoaki, Characteristics of several refractory metals, 17: 16712
TAKAHASHI, Takao, Effect of radiation on protein metabolism, 17: 15750
TAKAMATSU, Toshiaki, Flow temperature and crystallinity of copolymers produced by radiation, 17: 16081
TAKAMATSU, Toshiaki, Irradiation of polyvinyl chloride, 17: 16082
TAKAMORI, Yasuhiko, Chemical protection of lymphatic cells against γ irradiation, 17: 15833
TAKEDA, Atsuhiko, Deoxyribonucleoprotein of mouse spleen irradiated with γ rays, 17: 15706
TAKEDA, Gyo, Production of intermediate vector bosons, 17: 17036
TAKENO, Hyoitiro, Gravitational wave in general relativity, 17: 16858
TAKENO, Hyoitiro, Wave geometry, 17: 16859
TAKEUCHI, Y., Effects of γ irradiation on lipids of chicken egg yolk, 17: 15723
TAKI, Ko, Labeled organic compounds under irradiation. III., 17: 16083
TAKIZAWA, Masao, Radiation-induced oxidation in Sb(III)–Fe(II) solution. I., 17: 16080
TALLEY, Claude P., Preparation of high-purity single-crystal B, 17: 16635 (ASD-TDR-62-427)
TALWAR, S. P., Stability of rotating pinch, 17: 17381
TAMBIEV, A. Kh., Recovery of yeast after irradiation, 17: 15740
TANDON, J. N., Stability of rotating pinch, 17: 17381
TANIFUGI, Makoto, Knock-out mode in (d,p) and (d,n) reactions, 17: 17168
TANIFUJI, M., Cluster model in $Ne^{20}(\alpha,C^{12})C^{12}$, 17: 17195
TAPLIN, George V., Liver blood flow estimates, 17: 15543 (UCLA-511)
TARASEVICH, N. I., Effect of phosphomolybdate on determination of Nb and Ta, 17: 15930
TARASOV, L. K., Formation of $Zr^{97}Cl_4$ by slowing down of fission fragments, 17: 16065
TATEVSKII, V. M., Spectra of liquid deuterated hydrazine N_2D_4, 17: 16009
TATI, Takao, Unusual statistics of elementary particles, 17: 16977
TAUBE, Henry, Reactions of iodopentamminecobalt(III) with various "one-electron" oxidation-reduction reagents, 17: 15987
TAYLOR, Alan Frederick, Fuel elements for nuclear reactors, 17: 17525
TAYLOR, Anthony J., Nuclear reactors, 17: 17521
TAYLOR, B. L., Vacuum fusion apparatus for determination of O in UC and PuC, 17: 15872 (AERE-R-4216)
TAYLOR, Charles D., Hazards evaluation of HWCTR, 17: 17592 (DP-600)
TAYLOR, Colin, Servicing mechanisms for fluid-cooled reactors, 17: 17492
TAYLOR, Gerald R., Jr., Preparation of high-purity single-crystal B, 17: 16635 (ASD-TDR-62-427)
TAYLOR, H. W., Note on 2320-kev level in Zn-68, 17: 17142
TAYLOR, M. T., Magnetoplasma resonance in metals, 17: 16841
TAYLOR, Ph., Scattering of conduction electrons in metals, 17: 16967
TAYLOR, R. W., Jr., Prog. rpt. on hydraulic ball control system, 10–12/62, 17: 17412 (GNEC-264)
TCHOE, Yuong-Tchel, Chemical protection of lymphatic cells against γ irradiation, 17: 15833
TEDESCHI, Pete, Review of ANL radiation exposure experience, 1959–1961, 17: 16312 (ANL-6688)
TEICHMANN, T., Behavior of thin viscous film under mechanical and thermal forces, 17: 16225 (GAMD-2257)
TELEGDI, V. L., Measuring polarization of positrons, 17: 17004
TEL'KOVSKII, V. G., Breakdown of metals by ion beams, 17: 16818
TEMPLETON, David H., Crystal structure of $Eu_2(WO_4)_3$, 17: 16663 (UCRL-10344)
TEPLAN, Istvan, Preparation of phthaloylglycine-1-C^{14}, 17: 16035
TERASAKI, Hideo, Radiation-induced exchange of O in CO_2, 17: 15976
TEREKHOVA, V. F., Magnetic properties of Sc, 17: 16723
TERLETSKII, Ya. (J.) P., Positive, negative, and imaginary proper masses, 17: 16968
TER-MARTIROSYAN, K. A., Asymptotic values of amplitudes of inelastic processes, 17: 17100
TER VELD, L. K., Resonances in $P^{31}(p,\gamma)S^{32}$, 17: 17173
THACKER, D. G., Radiation biology in Canada 1962–1963, 17: 15627 (CRB-1129)
THODE, H. G., Isotope effects in biological and geological processes, 17: 15554
THOMAS, D. L., Angular distribution of photoproduction of positive pions from H by γ rays, 17: 16985
THOMAS, E. D., Irradiation and marrow infusion in leukemia, 17: 15546
THOMAS, E. Donnall, Infusion of marrow in the mouse and dog after thio-TEPA, 17: 15548
THOMAS, Stan, Count-rate-meter (n-decade), 17: 16879
THOMAS, T. Darrah, Fission induced by heavy ions in Au and Bi, 17: 17225
THOMASON, P. F., Chemical analysis of reactor fuels, 17: 15852 (ORNL-3397(p.17-24))
THOMASON, P. F., Organic preparations, 17: 15860 (ORNL-3397(p.113-16))
THOMASON, P. F., Special research problems, 17: 15854 (ORNL-3397 (p.26-38))
THOMPSON, A. R., Catalog of solar radio bursts, 17: 16912
THOMPSON, L. C., Observations on rare earths. LXXV., 17: 16001
THOMPSON, T. J., Prog. rpt. on D_2O lattice project, annual, 9/62, 17: 17419 (MITNE-26)
THORESEN, P., Fallout in Norwegian milk in 1961, 17: 15614 (A/AC.82/G/L.810)
THORNTON, R. M., Reducing reactor γ spectral data, 17: 16959
THOUVENIN, Pierre, Reactions (n,α) on Si-28 and Si-29 at 13.4 and 13.8 Mev, 17: 17145
THRESHER, J. J., Scattering of neutrons by U from 18 to 120 Mev, 17: 17159
THYSSEN, F., Welding plates for reactor construction, 17: 17438
TICHENOR, Doris A., Radiation effects on broccoli, sweet corn, and strawberries, 17: 15675
TIETGE, J., Study of 224 r^{n+} decays, 17: 17007
TILAK, V. V. S. S., Geochemical studies in U prospect. I., 17: 16303
TILLIEU, Jacques, Determination of eigen-energies and functions. II., 17: 17396
TILLOTSON, J. H., Optimum shadow shield, 17: 17392 (GAMD-2271)
TILLOTSON, J. H., Radioisotopes in ablation experiments, 17: 16223 (GAMD-2117)
TINKHAM, M., Transitions of superconducting films, 17: 16838

TINSLEY, Ian J., Prog. rpt. on effects of irradiated diet, 4/15–9/15/62, 17: 16362 (NP-12599)
TITEICA, S., Angular distributions of muons in π^- μ decay at rest, 17: 17019
TO, Ying-seb, Elastic p-p scattering at 8.35 Bev, 17: 16950 (JINR-P-1135)
TOBIAS, Cornelius, Effects of α particle radiation on rat brain, 17: 15695
TOBIN, A. G., Surface oxide films on Zr, 17: 16591 (NMI-1254(p.44-65))
TODOROV, I. T., Properties of meson–nucleon vertex portion, 17: 16966
TOKAREVSKII, V. V., Spins and parities of some states of Mo isotopes, 17: 17258
TOLHOEK, H. A., Weak interactions among nucleons and leptons, 17: 17309
TOLKACHEVA, E. N., Effects of chemicals on radiosensitivity of cells, 17: 15747
TOLLANDER, B., Computations for circular radiator and circular detector, 17: 16943 (AE-101)
TOLLER, M., Measuring the η^0 lifetime, 17: 17184
TOLMACHEV, Yu. N., Magnetic properties of U_3O_8, 17: 16674
TOMILCHIK, L. M., Existence of a monopole, 17: 17399
TOMONAGA, Sin-itiro, Quantum mechanics. I. Old quantum theory, 17: 16869
TOMOZAWA, Y., Note on local commutativity, 17: 16828
TONOLINI, F., Calculations of (n,α) cross sections at 14 Mev, 17: 17206
TONOLINI, L., Calculations of (n,α) cross sections at 14 Mev, 17: 17206
TOPE, W. G., Facility 350 He–atmosphere system, 17: 16171 (ANL-6489)
TOPP, N. E., Extraction of lanthanons with alkali metal amalgams. I., 17: 16157
TOPP, Stephen Vollery, Neutron polarization measurements using liquid He scatterer, 17: 17087
TORESSON, Y. G., Level $1s2s^3S$ of Li^+, 17: 16807
TORIZUKA, Y., Upper limit of electric dipole moment of electrons, 17: 17013
TORNAU, R., Determination of C/H ratio of hydrocarbons with neutrons, 17: 15891 (CEA-tr-A-1245)
TOSHINSKII, G. I., Calculations of fuel burnup in reactors, 17: 17464
TRETYAKOVA, Ch. A., Ionization bursts and spectrum of nuclear-active particles at mountain heights, 17: 16934
TRILLING, Charles A., [Effects of radiation on] coolants, 17: 16101
TRILLING, L., Dynamics of thermally radiating gas, 17: 16250
TRKA, Z., γ Production in interaction of π^- mesons with nuclei, 17: 17192
TRKA, Z., Radiative decays of resonance states, 17: 17119 (JINR-P-1164)
TROITSKII, O. A., Action of electron and γ radiation on Zn crystals, 17: 16676
TROITSKII, O. A., Effect of β irradiation and surface-active agent on Zn, 17: 16749
TROJANOWSKI, L., Radiation damage effects in Ba chromate crystals, 17: 16753
TROMMER, E., Analysis of nuclear fission products, 17: 15892
TROYANSKII, V. B., Two-group calculations for intermediate-thermal reactors, 17: 17462
TRUE, William W., Two-hole two-particle levels in Pb-208, 17: 17138
TRUEB, J., Irradiation capsules for Dragon fuel elements, 17: 16755
TRUMP, John George, Medium- to high-voltage generator, 17: 16200
TRUONG, T. N., Analysis of hypertriton by hard-core potentials, 17: 17014
TSAI-CHU, Method for study of multiple scattering, 17: 16815
TSAKADZE, Dzh. S., Formation of central vortex in rotating liquid He, 17: 16867
TSAKADZE, Dzh. S., Mutual friction between components of He II along axis of rotation, 17: 16866
TSAREV, B. M., Optical constants of LaB_6 and CeB_6, 17: 16714
TSEKHMISTRENKO, Yu. V., Inelastic scattering of neutrons by non-spherical nuclei, 17: 17248
TSEKHMISTRENKO, Yu. V., Scattering of neutrons by nonspherical nuclei, 17: 17246
TSIVENKO, V. I., Radicals in γ irradiation of solid ammonia and hydrazine, 17: 16093
TSU, T. C., MHD power generation and application, 17: 16188
TSUBOTA, Hiroyuki, Cesium-137 concentration in human urine, 17: 16343
TSUCHIYA, Takehiko, Effect of x irradiation in intestines of animals, 17: 15705
TS'UI, Wo-Chuang, p-p Scattering at 640 Mev. Estimation of singlet phase shifts. II., 17: 17051
TUBIANA, Maurice, Radiosensitivity of tumor predecessor, 17: 15671
TUCKER, W. E., Jr., Effects of irradiated dog food, 17: 16368 (NP-12606)
TUCKER, W. E., Jr., Effects of irradiated food, 17: 16369 (NP-12607)
TUCKER, W. E., Jr., Effects of irradiated dog food, 17: 16370 (NP-12608)
TUPIKOV, V. I., Radicals in γ irradiation of solid ammonia and hydrazine, 17: 16093
TURCOTTE, Donald L., Reply to comments by Probstein and Fay, 17: 17370
TURKEVICH, John, Electron paramagnetic resonance in molecular transfer complexes, 17: 16785 (NYO-3062)
TURNBULL, J. A., Electron microscope studies of graphitization and deformation in C film, 17: 16692
TURNER, B. A., Fractionated x-ray treatment of skin of pigs, 17: 15662
TURNER, S. E., Prog. rpt. on hydraulic ball control system, 10–12/62, 17: 17412 (GNEC-264)
TURNEY, G. E., Pyrolytic capsule fouling test, 17: 17423 (NAA-SR-Memo-8088)
TUTTLE, L. W., Strontium-90 in hair, 17: 15612
TYAN, M. L., Mouse fetal liver: source of immunologically reactive cells, 17: 15644 (USNRDL-TR-605)
TYAN, M. L., Radiosensitivity of responses to skin grafts, 17: 15646 (USNRDL-TR-619)
TZSCHASCHEL, R., Measurements of α activities with fast ionization chamber, 17: 16446

U

UDGAONKAR, B. M., Nucleon as a Regge pole, 17: 17038
UDO, F., Dissociation of deuterons, 17: 17185
UEBERALL, H., Polarizations in π-p and K-p scattering, 17: 17003
UEDA, Tomiko, Catalyst factor in exchange of paraxylene with D_2O, 17: 15863
UHLMANN, W., Bibliography on corrosion of stainless steel, 17: 16593 (VDIT-5a)
UHLMANN, W., Coordinate index to bibliography on radiation effects on U-based fuel materials, 1961–62, 17: 16747 (VDIT-16(Ind.61/62))
ULEHLA, Ivan, Optical model of the atomic nucleus, 17: 17279
UNGAR, Israel S., Radiolysis of the isomeric poly(butyl methacrylates), 17: 16070
UNGER, H., Reactor for energy requirements of electric propulsion, 17: 17608
UNO, Tadao, Plasma arc torch, 17: 16220
UNRUH, Wesley P., Direct spin-lattice relaxation processes, 17: 16839
UNRUH, Wesley P., Relaxation processes for divalent cobalt ions, 17: 16014
UNTERMYER, Samuel, Monitoring the power distribution in reactors, 17: 17510
UPOR, Endre, Fixation of radioactive elements by mineral coals, 17: 15968
URAZAKOV, E. I., Rotational magneto-mechanic effect in low-pressure plasma, 17: 17383
URBANSKI, Stefan, Logarithmic integrator types ILG-1 and ILG-2, 17: 16391
USACHEV, L. N., Spatial and angular distribution of spherical source neutrons, 17: 17459
USATYI, A. F., Radicals in proteins during irradiation, 17: 15766
USHAKOVA, A. M., Luminescent determination of U, Ce, and Nb, 17: 15928

V

VAINSHTEIN, E. E., Effect of additions of oxides on Mg–Mn ferrites, 17: 16019
VALE, Raymond Lester, Improvements in radiation indicators, 17: 16475
VALENTA, Miroslav, Influence of radiation on nucleic acids, vitality, and fecundating ability of male sexual cells, 17: 15689
VALTER, A. K., Elastic scattering of protons by Mg-24, 17: 17261
VAN ALLEN, J. A., Intensity of electrons in inner radiation zone, 17: 16920
VAN ALLEN, J. A., Intensities of geomagnetically trapped particles, 17: 16924
VAN BEKKUM, D. W., Immunological tolerance in radiation chimeras, 17: 15759

VANDAKUROV, Yu. V., Stability of conducting plasma cylinder in magnetic field, 17: 17376
VAN DE GRAAFF, Robert Jemison, Medium- to high-voltage generator, 17: 16200
VANDENBOSCH, R., Nuclear fission, 17: 17283
VAN DEN BRENK, H. A. S., Metabolic factors in radioprotective action, 17: 15794
VAN DER HOEVEN, B. J. C., Jr., Specific heat of Pb from 0.3 to 4°K, 17: 16834
VAN DER SLUYS, I., Effects of radiation on isolated DNA, 17: 15792
VANDER VEEN, Jering, Prog. rpt. on low heat flux boiling, 10/61–1/62, 17: 16231 (TID-15719)
VAN ELST, H. C., Prog. rpt. on ductile-brittle transition temperature, 10–12/62, 17: 16644 (EURAEC-561)
VANHORENBEECK, J., Isomeric level of Sb-122, 17: 17151
VAN HOVE, L., Ground state theory of imperfect Fermi gases, 17: 17061
VAN LINT, V. A. J., Correlation of radiation types with effects, 17: 16883
VAN LINT, V. A. J., Prog. rpt. on radiation effects on Si solar cells, 12/61–12/62, 17: 16736 (GA-3872)
VAN PATTER, D. M., E2/M1 mixing ratios for γ transitions in even nuclei, 17: 17205
VAN R. SMIT, J., Cesium separation by AMP process. IV., 17: 16139 (AERE-R-4245)
VAN TUBERGEN, R. P., Localization of H-3 label in bacteria, 17: 15596
VAN VOORHIS, Judith K., BEAM I: beams on elastic foundations, 17: 16173 (KAPL-M-JVM-4)
VAN VUCHT, Johannes H. N., Manufacture of Th-containing getters, 17: 16620
VANYUKOV, M. P., Radiation spectra of pulse discharge, 17: 16393
VARDI, Joseph, Thermal conductivity of molded and pyrolytic graphites, 17: 16678
VARSAVSKY, Carlos M., Prog. rpt. on photo processes in ionized O, 12/62–2/63, 17: 16791 (TID-18231)
VASILENKO, S. S., Positron decay of Re-182, 17: 17259
VASILENKO, V. T., Absorption spectra of Zr complexes and ionic forms of reagents, 17: 15927
VASIL'EV, A. A., Reducing injection energy in accelerators, 17: 17320
VASIL'EV, S. S., Sputtering of mica and quartz by Kr ions, 17: 16817
VASIL'EV, S. S., Mechanism of the $C^{12}(p,p'3\alpha)$ reactions, 17: 17174
VAUGHAN, B. E., Sodium dependence of bioelectric outputs in rat stomach, 17: 15645 (USNRDL-TR-608)
VAUGHAN, Dale A., Determination of thermal expansion by x-ray diffraction, 17: 16668
VAUGHN, Everett W., Therapy unit, 17: 16221
VAZE, P. K., Estimation of T by gas-phase counting, 17: 15871 (AEET/HP/TM-10)
VEBERSIK, Vlastimil, Electrolytic separation of RaD, RaE, and Po, 17: 16150 (CEA-tr-A-1291)
VEDULA, Yu. S., Effect of electron bombardment on adsorption properties of W surfaces, 17: 16713
VEILLET, Jean Jacques, Existence and spin of f° resonance, 17: 16965
VEKSLER, V. I., Unpaired collisions in interaction slow positive ions surface of a metal, 17: 17257
VELLENGA, L. R., Hemangioma of liver 25 years after injection of thorotrast, 17: 15691
VENKATERAMAN, B., Radiation-induced free radicals and identification, 17: 15763
VENNART, J., Assessment of the internal hazard, 17: 16334
VENTERS, Lydia, Pocket dosimeter with compass, 17: 16431 (AEC-tr-5558)
VENUTI, G. Campos, Negative pion absorption in complex nuclei, 17: 17108 (ISS-62/21)
VENUTI, G. Campos, Photoproduction from H of particles of 300 Mev, 17: 17109 (ISS-62/27)
VENUTI, G. Campos, Photoproduction from H of particles of 400 Mev, 17: 17110 (ISS-62/28)
VENUTI, G. Campos, Photoproduction from H of particles of 500 Mev, 17: 17111 (ISS-62/29)
VENUTI, G. Campos, Photoproduction from H of particles of 600, 900, and 1000 Mev, 17: 17112 (ISS-62/30)
VENUTI, G. Campos, Photoproduction from H of particles of 279.2 Mev, 17: 16947 (ISS-62/24)
VERBOVEN, E., Theory of electron transport, 17: 17064
VERDIER, Jacques, Ionization-type heat exchange process, 17: 16257
VERMILYEA, D. A., Stresses in anodic films, 17: 16685
VERTES, Paul, Apparatus for effecting continuous solid-gas reactions, 17: 16131
VERTUA, R., 2-Methylpiperazine dithioformate: liver and radio protector, 17: 15809
VERTUT, Jean, Ball and socket joints for remote controls, 17: 16219
VESELY, Vladimir, Radioactive waste disposal plant, 17: 17621
VETOR, E. L., Polarographic study of $Cu(Hg)_1$–$Cu(H_2O)^{++}$, 17: 15961 (TID-18198)
VIAR, William N., Radiation injury to rectum and sigmoid colon, 17: 15807
VILCOV, I., Angular distribution of polarized neutrons from $Li^7(p,n)Be^7$, 17: 17167
VILKOMIRSKII, I. E., Chlorination of loparite concentrate, 17: 16024
VILLAREAL, Rene U., Radiation-sensitizing agents in squamous cell carcinoma, 17: 15669
VILLARS, F., Effect of earth's magnetic field on irregularities of ionization in E layer, 17: 16283
VINETSKII, Yu. P., Effect of ionizing radiation on bacterial viruses, 17: 15791
VINOGRADOV, A. V., Determination of admixtures in alkaline metals, 17: 15923
VIOLA, Victor E., Jr., Fission induced by heavy ions in Au and Bi, 17: 17225
VISHNEVSKII, I. I., Polymorphous transformation of ZrO_2, 17: 16750
VIZBARAITE, Yu. I., Atoms with 1s and 2p electrons, 17: 16823
VLADIMIROV, V. I., Kinetic properties of rarefied plasma, 17: 17384
VLASOV, V. G., Reduction of uranoso-uranic oxide by dissociated ammonia, 17: 16125
VODROS, D., Active contaminant in Y-90, 17: 15911
VOELTZEL, Daniel, Reactor duct closure device, 17: 16214
VOGEL, Rudolf, System Fe–P–Nb, 17: 15971
VOGLER, F. H., Electrostatic shielding for space vehicles, 17: 17395
VOIKHANSKII, M. E., Radiation transitions in odd and odd-odd nuclei. I., 17: 17146
VOLKOV, I. I., Cinnamic acid in analytical chemistry. III., 17: 15924
VOLKOV, M. K., Calculations of strongly deformed element properties using superfluid nuclear model, 17: 17113 (JINR-E-1154)
VOLOCHINE, B., Ionization cloud chamber and application, 17: 16442
VOLODARSKAYA, R. S., Complexometric determination of Zr and Th, 17: 15921
VOLOKHOFF, D., Metallurgy and application of Zr, 17: 16707
VORESS, Hugh E., Bibliography on peaceful uses of nuclear explosives, 17: 15534 (TID-3522(Rev.6))
VORMUM, Guenther, Preparing an encased Kr-85 radiation source, 17: 16217
VOSHALL, Roy E., Ionization of gas by radiation from discharge, 17: 16812
VOZZELLA, P. A., Thermal decomposition of UC, 17: 15955 (PWAC-378)
VRATNY, F., Reflectance spectra of metallic oxides, 17: 15970
VRILLON, Bernard, Reactor support housing for fuel elements, 17: 17504
VULLIET, W. G., Diffraction of radiation around opaque disc, 17: 16945 (GAMD-1256)
VYSIN, V., Mechanics of bosons and fermions, 17: 16998

W

WABER, J. T., Oxide films on γ phase U alloys, 17: 16536
WABER, James T., Solid solubility in metallic alloys, 17: 16518 (LADC-5380)
WADA, Nobuo, Intensification factor of Pb screen for γ radiography, 17: 17394
WAECHTER, K. H., Determination of C/H ratio of hydrocarbons with neutrons, 17: 15891 (CEA-tr-A-1245)
WAEGNER, H., Atmospheric gravity waves from nuclear explosions, 17: 15538
WAGNER, E., Fast neutron leakage, EGCR, 17: 17554 (TID-18106)
WAGNER, E., Neutron flux distributions in EGCR, 17: 17566 (TID-18245)
WAGNER, Henry N., Jr., Studies of the reticuloendothelial system. I., 17: 15571
WAGNER, Henry N., Jr., Studies of the reticuloendothelial system. II., 17: 15572

WAGNER, R. P., Decomposition of PuF_6 by radiation, 17: 16045 (TID-18184)
WAGNER, S., Production of semiconductor detectors by Li drifting, 17: 16898
WAGNER, William G., Simplicity of Regge asymptotic amplitudes, 17: 17046
WAHSWEILER, Hans Georg, Rates for reaction $\mu^- + He^3 \rightarrow H^3 + \nu$, 17: 17049
WAINERDI, Richard E., Nuclear activation analysis, 17: 15914
WAINERDI, Richard E., Prog. rpt. on computer coupled automatic activation analysis and remote lunar analysis, 11/62–2/63, 17: 15888 (TID-18257)
WAKIYAMA, T., Magnetostriction and thermal expansion of Gd, 17: 16703
WALDRON, M. B., Phase diagrams of Pu alloys studied at Harwell, 17: 16566
WALES, W., Search for $\mu \rightarrow e + e + e$, 17: 17026
WALKER, A., Anhydrous nitrates of Group II metals, 17: 15995
WALKER, P. L., Jr., Prog. rpt. in fission gas diffusion in graphite, 6/62–5/63, 17: 16744 (TID-18112)
WALKER, Vincent, Improvements in fuel elements, 17: 17477
WALL, Frederick T., Diamines having two deuterium atoms, 17: 16039
WALL, P. G., Effects of x irradiation on differentiating Leydig cells of immature rat, 17: 15693
WALLACE, Roger, Argon–He scintillation, 17: 16794 (UCRL-10523)
WALLIS, Kenneth Basil, Composite closure means for arrangement of ducts, 17: 16201
WALSH, T. R., Measurement and shaping of emittance, 17: 17328 (NP-12635)
WALSH, William K., Prog. rpt. on radiation uses in textile industry, annual, 11/61–10/62, 17: 16041 (NCSC-2477-10)
WALTON, Alan, Distribution in soils of radioactivity from weapons tests, 17: 16288
WALTON, Brian, Improvements in electrical resistors, 17: 16205
WAMBERSIE, Andre, Practical dosimetry in interstitial therapy, 17: 15545
WANG, Chuang-peng, Secondary reactions of d and t capture, 17: 17116 (JINR-P-1157)
WARNER, C., III, Prog. rpt. on thermionic energy conversion, 11/61–10/62, 17: 16769 (AI-7979)
WARREN, Shields, Exposure rates and protective measures against radiation, 17: 16348
WARWICK, Constance S., Delay time of polar-cap blackout and delay time of geomagnetic disturbance, 17: 16289
WASSERMANN, Guenter, Deformation of Al single crystals, 17: 16720
WATANABE, S., Incidence of leukemias in Hiroshima, 17: 15825
WATERHOUSE, D. F., Insect control by radiation sterilization, 17: 15561
WATERS, J. R., Spark chambers with ferrite core memories, 17: 16427 (PPAD-461E)
WATERS, John R., Measuring particle velocities with Cherenkov rings, 17: 16453
WATSON, D. F., Prog. rpt. on effects of irradiated diet, 9/15/62, 17: 16363 (NP-12600)
WATSON, W. K. R., Solutions to Dirac equation with Yukawa potential, 17: 16990
WATTS, R. L., Problems in reactor theory and electrical engineering, 17: 17415 (HW-SA-2933)
WAUCHOPE, K. L., Preparation of Pu–Al fuel elements for NRX, 17: 16570
WAWNER, Frank E., Jr., Preparation of high-purity single-crystal B, 17: 16635 (ASD-TDR-62-427)
WAWRZYSZCZUK, Henryk, Logarithmic integrator types ILG-1 and ILG-2, 17: 16391
WEAR, J. O., Kinetics of the reduction of Np(V) with iodide ion, 17: 16003
WEAVER, J. T., EM field study of geomagnetic micropulsations near coastline, 17: 16269
WEBB, Edward L., Radio fluid detector, 17: 16482
WEBBER, W. R., Rigidity spectra for solar-flare cosmic rays, 17: 16927
WEBER, E., Radiochemical changes in polymers. I., 17: 16077
WEBER, H., Prog. rpt. on stratospheric monitoring, 12/60–1/61, 17: 16319 (NYO-9674)
WEDEMEYER, R., Molecular beam detector, 17: 16466
WEEMS, S. J., Prog. rpt. on hydraulic ball control system, 10–12/62, 17: 17412 (GNEC-264)
WEIGAND, Hans Hermann, Transformation of $\alpha + \beta$ Ti alloys with Al, 17: 16721
WEIGEL, F., Chemistry of transplutonium elements, 17: 15983
WEIGEL, H. W., Excretion of Na-22 in sweat, 17: 15700
WEIL, Louis, Ionization-type heat exchange process, 17: 16257
WEIL, Louis, Martensite transformation of 18-10 steel, 17: 16531
WEIL, Louis, Nature and production of active forms of H, 17: 15864
WEILL, Jacky, Control bar arrangement in atomic piles, 17: 17524
WEILL, R., Positron-electron annihilation in flight, 17: 16986
WEINBERG, A. F., Prog. rpt. on carbide cathode studies, final, 1/30/63, 17: 16774 (GA-3642)
WEINBERG, A. F., Prog. rpt. on carbides for thermionic space reactors, 11/30/62, 17: 16516 (GA-3866)
WEINREICH, Marcel I., Influence of atomic admixtures on thermal conductivity in crystalline lattice, 17: 15967 (SCL-T-468)
WEINSTEIN, D., Prog. rpt. on improved Zr alloys, 10–12/62, 17: 16582 (ARF-B198-36)
WEISE, L., Measuring time in counting nuclear radiation pulses, 17: 16449
WEISS, H., Measuring power of reactor impulses by Cherenkov radiation, 17: 17431
WEISS, J. J., Effects of radiations on nucleic acids, 17: 15771
WEISS, W. L., Silicon radiation detector tests, 17: 16896
WEISSGLAS, Peter, Matrix elements in an angular momentum repeesentation, 17: 16962
WELLS, Daniel R., Plasma rotation produced by electrodeless plasma gun, 17: 17361
WENDLANDT, W. W., Solvated 8-quinolinol and 2-methyl-8-quinolinol chelates of thorium(IV), 17: 16004
WENDT, G., 992 Kev $Al^{27}(p,\gamma)Si^{28}$ resonance, 17: 17200
WENDT, Jerome G., Spiral boiler evaluation, 17: 16227 (NAA-SR-Memo-7945)
WENG, T. S., Utilization of x-ray radiation for rice, 17: 15564
WENZEL, W. A., Elastic K^+-proton scattering, 17: 17015
WERNICK, R. J., Computer results in elastohydrodynamic equations, 17: 16660 (TID-18252)
WERTH, Glenn C., Amplitudes of seismic waves from nuclear explosions in four mediums, 17: 16286
WESKE, G., Reasons for the enrichment of Cs-137 in organisms, 17: 15621
WEST, G. L., Jr., Effects of ship motion on boiling water reactors, 17: 17578
WESTRUM, E. F., Jr., Preparation and micrometallurgy of Pu metal, 17: 16553
WEYHMANN, W., Beta-decay matrix elements in Sb-122, 17: 17215
WHARTON, A. E. B., Effects of high-altitude thermonuclear explosion, 7/62, 17: 16297
WHEAT, J. A., Spectrochemical determination of impurities in Np, 17: 15896
WHEELER, B. R., Radioactive demonstration of pot calcination process, 17: 17616 (IDO-14596)
WHELPLEY, W. A., Intensities of geomagnetically trapped particles, 17: 16924
WHITCOMB, Walter H., Protection against ionizing radiation, 17: 15633 (SAM-TDR-62-103)
WHITE, Frank M., Jr., Pneumatic pressure lag. I., 17: 16232 (TID-16555)
WHITE, J. C., Analysis of molten salts, 17: 15853 (ORNL-3397(p.24-6))
WHITE, J. C., Chemical analysis of reactor fuels, 17: 15852 (ORNL-3397 (p.17-24))
WHITE, J. C., Gas-cooled reactor project analyses, 17: 15855 (ORNL-3397 (p.38-54))
WHITE, J. C., Nuclear and radiochemical analyses, 17: 15858 (ORNL-3397(p.71-112))
WHITE, J. C., Organic preparations, 17: 15860 (ORNL-3397(p.113-16))
WHITE, J. C., Radiation effects on analytical methods, 17: 15856 (ORNL-3397(p.54-6))
WHITE, J. C., Special research problems, 17: 15854 (ORNL-3397(p.26-38))
WHITE, R. K., Behavior of rats resulting from fetal x irradiation, 17: 15655
WHITEHURST, Gordon William, Improvements in indicating or controlling devices, 17: 16398
WHITON, J. C., Reducing reactor γ spectral data, 17: 16959
WHITTAKER, J. Barrie, Bulk photoconductivity detector for γ rays, 17: 16451
WHITTEMORE, Osgood J., Jr., Process of making nuclear fuel element,

17: 16630
WHITWHAM, D., Prog. rpt. on preparation and irradiation of U–UC cermets, 3–6/61, 17: 16528 (EURAEC-126)
WICKRAMASINGHE, N. C., Interstellar polarization by graphite flakes, 17: 16915
WIDEROE, Rolf, European research center for radiation biology, 17: 15535 (UCRL-Trans-904)
WIEDEMANN, W., Magnetic and quadrupole moments of 8.42-kev state of Tm-169, 17: 17252
WIEGAND, D. A., Prog. rpt. on radiation effects on solids, 4/62–3/63, 17: 16746 (TID-18253)
WIKNER, E. G., Correlation of radiation types with effects, 17: 16883
WIKNER, E. G., Prog. rpt. on radiation effects on Si solar cells, 12/61–12/62, 17: 16736 (GA-3872)
WILCOCK, W. L., Symposium on photo-electronic image devices, London, 9/61, 17: 16394
WILDE, George R., Coding objects for self-organization, 17: 16506 (SCTM-251-62(24))
WILDGOOSE, Ronald, Improvements in nuclear reactors, 17: 17485
WILKINS, Wayne, Prog. rpt. on computer coupled automatic activation analysis and remote lunar analysis, 11/62–2/63, 17: 15888 (TID-18257)
WILKS, R. S., Mechanism of electrolysis of UO_2Cl_2 in NaCl–KCl, 17: 16005
WILLIAMS, Clarke, Prog. rpt. on reactor science and engineering, 10–12/51, 17: 17404 (BNL-164)
WILLIAMS, David C., Excitation functions and yields: Zn + d and $Ar^{40}(d,\alpha)$, 17: 17235
WILLIAMS, David C., Nuclear excitation functions: Ar-40, Zn-68(d,He-3), 17: 17234
WILLIAMS, David N., Invariant scattering amplitudes for arbitrary spins, 17: 17035
WILLIAMS, Frank, Improvements in heat exchangers, 17: 17474
WILLIAMS, Lawrence, Improvements in gas analysis apparatus, 17: 16396
WILLIAMS, Robert N., Reactors need superlative welding, 17: 16616
WILLIAMSON, G. K., Electron microscope studies of graphitization and deformation in C film, 17: 16692
WILLIAMSON, Stanley M., Reaction of XeF_4 with aqueous solutions, 17: 16020
WILLUHN, Klaus, Electric potential and field pattern in ionization chambers, 17: 16462
WILSON, John C., Method of cement detection by nuclear logging, 17: 16414
WILSON, R. K., Shielding problems for manned space missions, 17: 16877
WILSON, Robert E., Radioisotopes—their varied uses, 17: 16378
WINKLER, K., Welding plates for reactor construction, 17: 17438
WINSLOW, Fitz R., Fission-product migration in and release from Fe–20 wt % Cr, 17: 16638 (BMI-1611)
WINSTON, Roland, Hyperfine effects in μ capture by complex nuclei, 17: 17229
WINTHER, A., Effect of pairing correlations on β decays, 17: 17182
WISECUP, W. G., Effects of divided doses of x ray on mortality and hematology, 17: 15804 (USNRDL-TR-606)
WITTEN, L., Proton radiation dosage in vehicle in trapped belt, 17: 16876
WITTENBERG, I. J., Physical peculiarities of Pu, 17: 16669
WITTKOWER, A. B., Hydrogen ion beam from duoplasmatron source, 17: 16833
WOLF, W. P., Raising of angular momentum degeneracy of f-electron terms, 17: 15940 (AFCRL-62-929)
WOLFENDALE, A. W., Cosmic rays, 17: 16936
WOLFGANG, Richard, Reaction mechanisms of recoil C atoms, 17: 16078
WOLKE, R. L., Stopping cross sections of low-energy tritons, 17: 17212
WONG, C., Direct (p,n) reaction in medium A nuclei, 17: 17226
WOOD, G. M., Cavitation studies of flow pump impellers, 17: 16244
WOOD, J. I., NORA—zero-power experimental reactor facility, 17: 17595 (KR-41)
WOOD, P. M., Radial fast neutron leakage from EGCR, 17: 17564 (TID-18243)
WOOD, R. F., Hyperfine interaction in Li, 17: 16846
WOOD, Thomas Wendell, Mechanical properties of Nb, 17: 16728
WOODESON, James Brewis, Improvements in steam generators, 17: 16255
WOODS, Frank W., Methyl bromide for increasing I-131 uptake by pine trees, 17: 15735
WOODS, G. T., Adsorption of anionic complexes on cation-exchange resin, 17: 15992
WOODS, L. A., Preparation of H^3-labeled normorphine and physiology, 17: 15601
WOODS, L. A., Preparation of H^3-labeled morphine and biotransformation, 17: 15602
WRAY, L. W., X-ray emission determination of Fe in terphenyl, 17: 15897
WRIGHT, J. H., MHD power generation and application, 17: 16188
WRIGHT, R. L., Boron compounds for neutron capture therapy. I., 17: 15575
WRIGHT, Robert Andrew, Improvements in nuclear reactor servicing machines, 17: 17490
WUNSCHEL, Kenneth, Prog. rpt. on chelating agents for urinary excretion of Sr, 12/61–12/62, 17: 15589 (TID-18058)
WYATT, J. L., Prog. rpt. on electrodeless pulse plasma propulsion, final, 7/61–11/62, 17: 16771 (ASD-TDR-62-1105)
WYATT, M. E., Jr., Prog. rpt. on radiation effects on Si solar cells, 12/61–12/62, 17: 16736 (GA-3872)
WYDE, S. S., Sr., Prog. rpt. on heat rejection in space power plants, 9–11/62, 17: 16230 (PWA-2132)
WYLUDA, B. J., Knight shifts in Nb–Mo alloys, 17: 16709

Y

YALTKAYA, E., Neutron-scattering estimation of cement content of concrete, 17: 15901
YAMABE, Shotaro, Angular distributions of (α,n) reactions on Be and C, 17: 17154
YAMAGATA, Noboru, Concentration of Cs and Rb in human body, 17: 15603
YAMAMOTO, Albert S., Prog. rpt. on Nb-rich region of ternary phase diagrams, 12/62–3/63, 17: 16641 (DRI-2091)
YAMAMURO, Nobuhiro, Photoprotons from Mg, 17: 17152
YAMAZAKI, Mikio, Carbon-14 in a biological environment. I., 17: 15618
YAMAZAKI, Takoshi, Angular distributions of (α,n) reactions on Be and C, 17: 17154
YAMDAGNI, N. K., Binding energies of Λ^0 hyperon in hypernuclei, 17: 17175
YANG, L., Prog. rpt. on carbide cathode studies, final, 1/30/63, 17: 16774 (GA-3642)
YANG, L., Prog. rpt. on carbides for thermionic space reactors, 11/30/62, 17: 16516 (GA-3866)
YANG, N. C., Polarographic oxidation potentials of aromatic compounds, 17: 16033 (TID-18149)
YANG, Won-Jei, Prog. rpt. on low heat flux boiling, 10/61–1/62, 17: 16231 (TID-15719)
YANOVA, K. G., Radiation stability of heterocyclic compounds, 17: 16063
YARINSKY, Allen, Histopathologic study of immunized mice exposed to total-body x irradiation, 17: 15654
YATSENKO, T. K., Diffusion of Fe in Fe–Hf alloys, 17: 16546
YELPAT'EVSKAYA (YELPAT'YEVSKAYA), G. N., Chronic radiation sickness induced by external irradiation, 17: 15805 (JPRS-18153)
YOSHIDA, Isao, Effect of γ rays on *Bacillus anthracis*, 17: 15718
YOSHIDA, Sanae, Irradiation of polyvinyl chloride, 17: 16082
YOSHIKAWA, K., Fractionation in fallout particles, 17: 16344
YOUMANS, A. H., Instrumentation for lunar surface analysis, 17: 16894
YOUNG, A. G., Collapse in alpha U subjected to thermal cycles, 17: 16689
YOUNG, F. W., Jr., Visit to Soviet corrosion chemistry institutes, 6/25–7/4/62, 17: 16592 (TID-17940)
YOUNG, Peter F., Corrosive effects of Rb on alloys from 1000 to 2000°F, 17: 16634 (AGN-8063)
YOUNG, Robert J., Protection against ionizing radiation, 17: 15633 (SAM-TDR-62-103)
YOUNG, W. O., Survey of dental x-ray machines in Idaho, 17: 16340
YU, Kung, Thermonuclear energy, 17: 17353
YUDKEVICH, M. S., Thermal neutrons in homogeneous moderator mixture, 17: 17465
YUNIS, Edmund, Suspensions of spleen and bone marrow for treatment of supralethally irradiated dogs, 17: 15845
YURIN, V. A., Effect of γ radiation on piezoelectric and elastic properties of triglycinsulfate crystals, 17: 16860
Yutsis, A. P.
see Jucys, A. P.

Z

ZACHARIASEN, W. H., Crystal-structure studies of Pu metal, 17: 16559
ZACHARIASEN, W. H., Crystal structure of beta Pu metal, 17: 16648 (LADC-5373)
ZACZEK, T., Effects of x radiation on toxicity of pharmaceuticals, 17: 15678
ZAGORSKAYA, M. K., Spectrographic determination of admixtures in high-purity La oxide, 17: 15932
ZAHN, P., Energy distribution of α-recoil nuclei in Formvar, 17: 17249
ZAIDEL, A. N., Spectrometric determination of Pb-204, 17: 15905
ZAIKA, N. I., Spins and parities of some states of Mo isotopes, 17: 17258
ZAIMIDOROGA, O. A., Probabilities of $\mu^- + He^3 \rightarrow He^3 + \nu$ reaction, 17: 17278
ZAK, J., Nuclear relaxation time in mixed Na salts, 17: 16018
ZAKHARCHENYA, B. P., Luminescence spectrum of $CaF_2:Sm^{++}$ and $SrF_2:Sm^{++}$ crystals, 17: 16011
ZALKIN, Allen, Crystal structure of $Eu_2(WO_4)_3$, 17: 16663 (UCRL-10344)
ZAMICK, Larry, Scattering of high-energy deuterons by complex nuclei, 17: 17122 (PUC-1962-78)
ZAMIR, D., Nuclear relaxation time in mixed Na salts, 17: 16018
ZATRUTINA, R. F., Bibliography of IGY literature published in Russian in 1960, 17: 16266 (NASA-TT-F-109)
ZELLE, M. R., Biological and agricultural uses of radiation, 17: 15556
ZERBY, C. D., Collimator study for 20-Bev electron beam, 17: 17315 (ORNL-TM-524)
ZERBY, C. D., Expressions for 3-j symbols, 17: 16957 (ORNL-TM-514)
ZHEREBCHENKO, P. G., Radiation protection with indole series, 17: 15842
ZHIGLINSKII, A. G., Spectrometric determination of Pb-204, 17: 15905
ZHMAILO, V. A., Packing of excitation levels of light nuclei near thresholds, 17: 17099
ZHUKOVSKII, V. M., Reduction of uranoso-uranic oxide by dissociated ammonia, 17: 16125
ZHURAVLEVA, T. S., EPR spectra of γ-irradiated multibond compounds, 17: 16067
ZIELINSKI, P., Interactions of protons with heavy nuclei, 17: 17161
ZIEMBA, F. P., Semiconductor detectors for space spectrometry, 17: 16895
ZIFFERERO, M., Extraction of Pu(IV) nitrate with tertiary amine nitrates, 17: 16154
ZIFFERERO, M., Extraction of U(VI) from HNO_3 solutions, 17: 16155
ZIMMERMAN, D. L., Irradiation of reactor control materials, 17: 16737 (GEAP-3927)
ZIPF, T. F., Elastic K^+-proton scattering, 17: 17015
ZIPPE, Gernot, Apparatus for producing difference in pressure between interconnected gas chambers, 17: 16215
ZOLOTUKHIN, V. G., Energy and angular distributions of γ quanta passing through finite thickness, 17: 17466
ZOLOTUKHIN, V. G., Mathematical-statistical treatment of nuclear-physical measurements, 17: 17471
ZORN, Jens C., Electron-proton charge difference and charge of neutron, 17: 17012
ZUKAS, E. G., Behavior of Fe–Si alloys under impulsive loading, 17: 16649 (LADC-5396)
ZULKARNEEV, R. Ya., p-p Scattering at 640 Mev. Estimation of singlet phase shifts. II., 17: 17051
ZUROMSKY, G., Prog. rpt. on burnable poison additions to UO_2, 12/62, 17: 16605 (CEND-173)
ZUSMAN, A., Spectrum of Gd in $LaAlO_3$, 17: 16016
ZVARA, I., Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
ZVARA, I., Formation of $Zr^{87}Cl_4$ by slowing down of fission fragments, 17: 16065
ZVAROVA, T., Fission of U-238 by Ne-22 ions, 17: 17114 (JINR-P-1148)
ZVAROVA, T. S., Formation of $Zr^{87}Cl_4$ by slowing down of fission fragments, 17: 16065
ZWICKER, U., Copper–Zr alloys. I., 17: 16706

SUBJECT INDEX

Main entries in this index are generally specific materials, things, and processes. These are followed by modifiers that describe the properties of, and processes applied to, the main entries. A more complete description of the patterns and style of indexing used is included in the introductions to the subject index cumulations that are issued quarterly.

As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number in that volume. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Published literature (journal article or book) is identifiable by the absence of a report number.

A

A-286 ALLOY
radiation effects on stress-rupture properties, 17: 16745 (TID-18150)
ABSORPTION SPECTRA
gamma ray resonance, effect of intracrystalline fields on shape of, 17: 17272
ABSTRACTS
on liquid metals technology, Sept. 1962 to Feb. 1963, 17: 16519 (LM-TAB-21)
on separation of hexavalent uranium from aqueous solutions by anion exchange, 17: 16148 (VDIT-70)
on solid-state properties of bismuth and tellurium alloys and compounds, 17: 16655 (SB-62-62)
ACCELERATORS
beam-injection energy for, possibility of reducing, 17: 17320
beam transport system design and construction for, 17: 17328 (NP-12635)
design and operation of solenoidal transmission-line, 17: 16771(R) (ASD-TDR-62-1105)
electron injection into annular, influence on intensity of injection voltage rise rate, 17: 17312 (IS-522)
magnetic field topography in radial sector, 17: 17311 (CERN-62-34)
particle azimuthal motion in circular, numerical analysis, 17: 17322
space charge effects in circular, treatment of nonlinear azimuthal, 17: 17314 (MURA-654)
use of nsec-pulsed, for analyses of nuclear reactions, 17: 17282
ACETIC ACID
effects on radioinduced graft polymerization, 17: 16041(R) (NCSC-2477-10)
ACETIC ACID, [(CARBOXYMETHYLIMINO)BIS(ETHYLENENITRILO)] TETRA-
complexes with mercury and rare earths, formation and stability constants of, 17: 16001
ACETIC ACID, IODO-
radiosensitivity effects on erythrocytes, 17: 15786
ACETIC ACID, PHENYL-
dissociation constant of alpha-deuterated-, potentiometric and spectrometric determination of, 17: 15990
ACETIC ACID, *N*-(2-PYRIDYLMETHYL) IMINODI-
complexes of, with metals, preparation and stability constants of, 17: 15993
ACETIC ACID, (TRIETHYLENETETRAAMINE)HEXA-
effectiveness in removal of strontium-90 from animals, 17: 15589(R) (TID-18058)
preparation, 17: 15589(R) (TID-18058)
ACETYLENE
radiation effects on electron paramagnetic resonance spectrum of, 17: 16067
ACIDS
ionization constants, effects of water-d_2 on, 17: 16022
ACRIFLAVINE
radiosensitivity effects on yeasts, 17: 15793
ACRYLONITRILE POLYMERS
radiopolymerization to monomers for improved dyeability, 17: 16112(P)
ACRYLONITRILES
radioinduced graft polymerization to textiles, 17: 16041(R) (NCSC-2477-10)
ACTINIUM
structure, 17: 16559
ACTIVATION ANALYSIS
automation of, by use of computers, 17: 15888(R) (TID-18257)
development and uses, 17: 15858(R) (ORNL-3397(p.71-112))
development for lunar and planetary surface determination, 17: 15888(R) (TID-18257)
development of methods of, for lunar-surface studies, 17: 16894
graphical method for rapid estimation, 17: 15915
methods of, for elemental analysis of ocean-bottom cores, 17: 15886 (TID-18125)
neutron absorption in pile, effects of, 17: 15877 (MMPP-226-1)
review of developments, 17: 15914
use, for process analyses using non-radioactive tracers, 17: 15913
use of neutron, in determination of titanium, 17: 15884 (TID-16522)
ADENOSINEPHOSPHORIC ACIDS
protective effects of, against radiation in mice, 17: 15826
ADHESIVES
radiation effects, 17: 16103
radiation effects, 17: 16724
ADRENAL HORMONES
radiation effects on adrenocortical steroid synthesis in rats, whole-body, 17: 15808
ADRENALINE
protective effects of, against skin absorption of beta particles by rats, 17: 15553
protective effects of, against radiation in mice, 17: 15826
radiation effects on cardiac sensitivity to, 17: 15840
ADVANCED ENGINEERING TEST REACTOR
fuel elements for critical experiment for, loading control of driver, 17: 17598 (TID-18121)
ADVANCED TEST REACTOR
critical experiments, pile oscillator excitation in, 17: 16942 (TID-18064)
critical experiment for, temperature effects on reactivity in, 17: 17599 (TID-18254)
AEROSOLS

fixation of radioactive ions on atmospheric, 17: 16271
particle size in natural radioactive, 17: 16279
properties of radioactive, methods for determination of, 17: 16327(R) (ORNL-3401(p.43-55))

AGE ESTIMATION
involving radiogenic isotopes of lead, discrepancy, 17: 16301
lead-isotope ages of uranium minerals, methods for evaluating discordant, 17: 16308
radiocarbon dating of upper paleolithic period in region adjoining Dniester River, 17: 16273

AIR
air-water, flow through tubes, 17: 16233(R) (TID-18141)
convection transients from flat vertical surfaces, natural, 17: 16246
electric discharge in, ionization processes in, 17: 16812
heat transfer in partially ionized, stagnation-point, 17: 16252
iodine removal from, by sorption on copper, 17: 16008
oxidizing effects on purified graphite, 17: 15966(T) (NP-tr-958)
radioactivity of, measurements in Federal Republic of Germany, January to March 1962, 17: 15624
radioactivity of, measurements in Federal Republic of Germany, April to June 1962, 17: 15625
separation from water by gravity, carry-under studies, 17: 16240
triton ranges and stopping cross sections in, 17: 17212

ALANINE
radiation effects on, 17: 15772

β-ALANINE, 2-METHYL-
radiation effects on excretion and plasma levels of, in cancer patients, 17: 15784

ALANINE, PHENYL-
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668

ALBUMINS
radiation effects on bovine serum, solid state processes in, 17: 15772

ALDEHYDES
oxidation of, by bromine, deuterium isotope effects in, 17: 16037

ALKALI METAL AMIDES
preparation of ammoniacal solutions, 17: 15870(P)
regeneration of catalyzers of, 17: 16500(P)

ALKALI METAL FLUORIDES
alkali metal fluoride–U, spectra of, magneto-electric transitions in, 17: 15981

ALKALI METAL HALIDES
radiation effects, 17: 16746(R) (TID-18253)

ALKALI METALS
analysis of, for admixtures in, chemical spectrographic, 17: 15923
isotope separation by countercurrent electromigration in fused salt, cell for, 17: 16498(P)

ALKALINE EARTH HALIDES
preparation, 17: 15859(R) (ORNL-3397(p.112-13))

ALKENES
radioinduced polymerization, 17: 16122(P)

ALLOYS
analysis of, for iron, manganese, niobium, tantalum, and tin, x-ray spectrum, 17: 15900
book: *The Influence of Temperature on the Mechanical Properties of Metals and Alloys*, 17: 16725
electronic specific heat of body-centered-cubic and face-centered-cubic solid solutions of first long period transition elements, 17: 16698
localized electron spins in transition-metal, 17: 16697
nuclear magnetic resonances in ferromagnetic, 17: 16700
solid solubility in metallic, methods of predicting, 17: 16518 (LADC-5380)

ALPHA DECAY
regularities in nuclei with less than 126 neutrons, 17: 17256

ALPHA PARTICLES
angular distribution from beryllium-9 (d,α) reactions, 17: 17245
chemical effects on hydrogen peroxide and water, 17: 16058(T) (AEC-tr-5687)
detection and measurement by fast ionization chamber and methane flow counter, 17: 16446
detection in airborne radioisotopes, design of solid-state detectors for, 17: 16332(R) (UCRL-7143)
effects of, on glycogen content and vascular permeability in rat brain, 17: 15695
effects of recoil, on performance of proportional detectors, 17: 16435
ionization of argon, nitrogen, and argon-methane systems, slow component in, 17: 16849
neutron elastic scattering by, 17: 17094 (TID-18277)
reactions (α,α′γ) and (α,pγ) with carbon-12 and neon-20, particle-gamma coincidence, 17: 17290
reactions (α,C^{12}) with neon-20, angular distribution in cluster model analysis of, 17: 17195
reactions (α,n) and (α,p) with beryllium-9 and carbon-12, 17: 17154
reactions (α,p) with carbon-12, backward peaks in angular distributions from, 17: 17188
reactions (α,xn) with niobium-93, excitation functions, isomeric ratios, and product recoil ranges for, 17: 16047(R) (TID-18261(p.1-14))
reactions (α,2p) with indium-115, production of indium-117 isomers in, 17: 16048(R) (TID-18261(p.15-18))
reactions with cadmium sulfide crystals, effects of electrode contacts on pulses induced by, 17: 16092
reactions with calcium-40, 17: 17218
spectra from lithium-7 (d,α) reactions, 17: 17223
spectra from reactions of lithium-6 on lithium-7 at 2 Mev, 17: 17197

ALTIMETERS
design and performance of light-weight, 17: 16320(R) (NYO-9675)

ALUMINUM
alloying effects on titanium, 17: 16580(P)
analysis and fabrication of, 17: 16594(T,R) (EURAEC-29)
argon-ion reactions on, secondary from, 17: 16836
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
corrosion by ammonium nitrate and ammonium phosphate solutions, 17: 16594(T,R) (EURAEC-29)
corrosion in air at 400 to 500°C, 17: 17404(R) (BNL-164)
determination by x-ray spectrometry using electron-beam excitation, 17: 15908
determination in graphite, activation, 17: 15916
determination in neptunium by ion exchange and spectrography, 17: 15896
determination in ocean-bottom cores by activation analysis, 17: 15886 (TID-18125)
determination of, in uranium fission products, 17: 15892
electron penetration through, energy distribution in, 17: 16972
fabrication of getters containing, 17: 16620(P)
light emission from, at 50°C in 0.25 to 27 μ wavelength region, 17: 15953 (NASA-TN-D-1523)
neutron elastic scattering and polarization by, at 2.8 Mev, 17: 17294
performance as shielding for manned space vehicles, 17: 16877
proton reaction at 120 and 660 Mev, 17: 17149
radioautography of structure using tritium, 17: 16539
reactions with plutonium fluorides and oxides, 17: 16568
triton ranges and stopping cross sections in, 17: 17212
use for shielding for cobalt-60 gamma sources, 17: 15663

ALUMINUM ALLOYS
analysis for thorium and zirconium using xylenol orange, 17: 15921
radiation and temperature effects on mechanical and physical properties of, 17: 16760
Al–Au, use as tracer for process analyses, 17: 15913
Al–Be–Fe, structure of phases, 17: 16691
Al–Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Cr–Fe–Ni–Ti, precipitation processes in, 17: 16718
Al–Cr–Fe–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Cr–Ti, transformation behavior in, during cooling, 17: 16721
Al–Cu–Mn, neutron diffraction study of κ magnetic phase of, 17: 16702
Al–Fe, radiation effects on, 17: 16541
Al–Mo–Sn–Zr, properties as claddings for uranium carbide fuels, 17: 16650 (NAA-SR-7696)
Al–Mo–Ti, transformation behavior in, during cooling, 17: 16721
Al–Nb–Sn, crystal structure and alloying properties, 17: 16727
Al–Pu, chemistry and metallurgy of, 17: 17439
Al–Pu, development at Chalk River, 17: 16556
Al–Pu, phase diagram, 17: 16567
Al–Pu, preparation and properties, 17: 16558

Al–Pu, preparation, 17: 16568
Al–Pu, preparation for NRX fuel elements, 17: 16570
Al–Ti, mechanical properties and strength, 17: 16677
Al–Ti–V, transformation behavior in, during cooling, 17: 16721
Al–U, preparation of, uranium-235 loading control in, 17: 17598 (TID-18121)

ALUMINUM CHLORIDES
chlorine-36 exchange from, to nitrosyl and phosphoryl chlorides, 17: 15996

ALUMINUM COUPLES
Al/stainless steel, corrosion, 17: 16584(R) (EURAEC-550)

ALUMINUM CRYSTALS
deformation of, embedded in aluminum extrusion billets, by extrusion processes, 17: 16720

ALUMINUM ISOTOPES Al-27
neutron capture at 14 Mev, gamma spectra from, 17: 17207
proton reactions (p,γ), decay scheme and spin assignment for 992-kev resonance in, 17: 17200

ALUMINUM OXIDE COMPACTS
properties of thin, 17: 17317(R) (SLAC-8)

ALUMINUM OXIDE FILMS
stresses in, measurements of, 17: 16685

ALUMINUM OXIDES
diffusion processes in, effects of grain boundaries on, 17: 16679
mechanical properties of, determination at temperatures to 5000°F, 17: 16178(R) (TID-17887)
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
Al_2O_3–B_4C, burnup, effects of boron-10 on, 17: 15532(R) (BMI-1607 (Del.))
Al_2O_3–Fe_2TiO_4, emissivity of, measurements of, 17: 16787(R) (PWA-2163)

ALUMINUM POWDERS
creep-rupture of sintered alloys of, at 700, 800, and 900°F, 17: 15532(R) (BMI-1607(Del.))

AMERICIUM
properties and chemical separation methods of, 17: 15972
structure, 17: 16559

AMERICIUM ISOTOPES Am-241
alpha emission, energy of intense groups, 17: 17143

AMIDE POLYMERS
preparation of light-resistant, from deuterium-containing diamines, 17: 16039(P)
radiation effects on, electron spin resonance spectra of radicals in, 17: 16069

AMINES
determination of tertiary alkyl, using cobalt thiocyanate, 17: 15906
preparation of light-resistant polyamides from deuterium-containing, 17: 16039(P)
radioinduced reactions with peroxides to form diaryl nitrogen oxide radicals, 17: 16064
radiosensitivity effects of, on mammals, 17: 15753
solvent properties of nitrates of tertiary, for plutonium nitrate, 17: 16154

AMINO ACIDS
optical rotatory dispersion of protein configuration dependence on, 17: 16032 (TID-18142)
radiation effects on excretion and plasma levels of, in cancer patients, 17: 15784
radioinduced free radicals in, 17: 15767

AMMONIA
radiolysis of solid, production of radicals in, 17: 16093
radiolysis products of, 17: 16043(R) (TID-18094)
reaction with uranium(IV–VI) oxides, thermodynamic, 17: 16125

AMMONIUM CHLORIDES
benzyl-, dissociation constants of alpha-deuterated, 17: 15990

AMMONIUM HYDROXIDES
reactions with uranyl nitrate, conductometric studies, 17: 15999

AMMONIUM NITRATES
corrosive effects on aluminum, 17: 16594(T,R) (EURAEC-29)

AMMONIUM PHOSPHATES
corrosive effects on aluminum, 17: 16594(T,R) (EURAEC-29)
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970

AMMONIUM PHOSPHOMOLYBDATES
effects of, on spectrographic determination of niobium and tantalum, 17: 15930
sorptive properties for cesium-137, 17: 16139 (AERE-R-4245)
use as ion exchanger in separation of naturally occurring radioisotopes, 17: 16159

AMMONIUM URANATES
precipitation, conductometric studies, 17: 15999

AMPLIFIERS
design and operation of transistorized pulse, 17: 16381 (CEA-1932)
design of cyclotron-wave parametric, with decreased magnetic bias, 17: 16406(P)
design of flexible, linear, pulse, 17: 16880

AMYLASES
taka-, radiation effects on activation of, protective effects of inorganic salts against, 17: 15592

AMYLOSES
radioinduced splitting of molecules of, in starch solutions, 17: 16087

ANEMIA
diagnosis of, tracer methods, 17: 15549
erythrokinetic studies in diagnosis, survey of isotopic tracer techniques, 17: 15577

ANILINE
methyl-2,4-dinitro-, dissociation constants of alpha-deuterated, 17: 15990

ANIMAL CELLS
radiation effects in muscle, 17: 15641 (TID-18221)
radiation effects on muscle membrane, 17: 15642(R) (TID-18268)
radiation effects of 30-Mev electrons, 17: 15648
radiation effects on mouse stem cells *in vivo*, 17: 15725
radiation effects on, direct and indirect, 17: 15769
radiation effects on content of DNA precursors in, 17: 15782
radiation effects on HeLa, in tissue cultures from lutetium-177 and phosphorus-32, 17: 15707
radiation injuries in human tissue culture, protective effects of yeast ribonucleic acid, 17: 15803 (SAM-TDR-62-85)
radiosensitivity of normal and malignant, 17: 15657
radiosensitivity of normal and malignant, 17: 15658
radiosensitivity of normal and malignant, 17: 15659
radiosensitivity of normal and malignant, 17: 15660
radiosensitivity of, effects of 5-iododeoxyuridine on, 17: 15670

ANIMAL REPRODUCTION
radiation effects in cattle, 17: 15541(R) (ORO-598)

ANIMALS
carcinogenic effects of inhaled beryllium compounds on, 17: 15835
cesium-137 uptake by, under natural conditions, 17: 16304
radiation tolerance dose to ovaries in, 17: 15594

ANION EXCHANGE MATERIALS
distributions of elements in, from nitric acid, synergistic effects of thorium on, 17: 15948 (LA-2836)
use of hydroxide and sulfate, for separation of radioactive trace elements from sulfuric acid solutions, 17: 16138 (AE-103)

ANNEALING
effects on mechanical properties of irradiated stainless steel at 1000 and 1800°F, 17: 16733 (BMI-1621)
point defect-dislocation interactions in, 17: 16657 (TID-16506)

ANOXIA
protective effects against x radiation in animal cells, 17: 15769

ANTIBODIES
radiation effects on production mechanisms, 17: 15639(R) (TID-18194)
radiation effects on formation, 17: 15647(T) (JPRS-18020)

ANTIGENS
radiation effects on production mechanisms, 17: 15639(R) (TID-18194)
radiation effects, 17: 15848
response, suppression by anti-tumor agents, 17: 15584

ANTIHYPERONS
decay of, angular correlations for mesons (π), 17: 16984

ANTIMONY
photon elastic scattering at particle threshold energy, cross sections for, 17: 17153
proton reactions at 100 Mev, isomeric state from, 17: 17141
proton reactions at 120 and 660 Mev, yields from, 17: 17149
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-

20)
ANTIMONY ALLOYS
Sb–Ge–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Sb–Nb–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
ANTIMONY IONS
radioinduced oxidation of, in aqueous solutions with iron(II) ions, 17: 16080
ANTIMONY ISOTOPES Sb-122
beta decay matrix elements in, 17: 17215
isomeric level of, at 159 kev, characteristic and period of, 17: 17151
ANTIMONY OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
ANTIMONY SYSTEMS
Sb–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
ANTINEUTRINOS
density of, in universe, experimental and theoretical data on, 17: 16910
interactions with electrons, charge renormalization in elastic, 17: 16958 (UCRL-10336)
properties in space, 17: 16917
ANTINUCLEONS
interactions with nucleons, hyperon isobars from, 17: 16995
ANTIPROTONS
existence of galactic, 17: 16911
interactions in flight, one-particle exchange in, 17: 16984
interactions with protons at low energy, cross sections for annihilation and charge-exchange in, 17: 17006
APATITES
isotopic exchange of calcium ions in, with phosphate ions, 17: 15581
APPENDIX
effects on radiation resistance of animals, 17: 15754
ARCHEOLOGICAL SPECIMENS
applications of isotope effects in studies of, 17: 15554
ARGON
electric glow discharge in, electromagnetic waves from, 17: 16889
ionization by alpha particles, slow component in, 17: 16849
plasma of, magnetic interaction effects in moving, 17: 17345
proton reactions on, ionization cross sections in, 17: 16886
testing for use in cooling systems for fuel handling casks, 17: 17545 (NAA-SR-Memo-8053)
thermal accommodation during adsorption of potassium and cesium on tungsten, 17: 16027
triton ranges and stopping cross sections in, 17: 17212
ARGON IONS
reactions on copper crystals, secondary electrons from, 17: 16837
reactions on metals, secondary electrons from, 17: 16836
sputtering reactions with copper at 25 kev, effects of angle of incidence on, 17: 16818
ARGON ISOTOPES Ar-36
interactions with alpha particles (α,γ), dependence upon resonance levels, 17: 16916
ARGON ISOTOPES Ar-39
energy levels in, from neutron reactions in potassium-39, 17: 17196
ARGON ISOTOPES Ar-40
deuteron reactions (d,He^3), excitation functions for, 17: 17234
deuteron reactions (d,α), excitation functions and thick-target yields for, 17: 17235
proton reactions (p,n) on, spectra from, 17: 17226
ARGON SYSTEMS
Ar–CH_4, ionization by alpha particles, slow component in, 17: 16849
Ar–He, scintillation properties, 17: 16794 (UCRL-10523)
ARGONNE FAST SOURCE REACTOR
fuel element fabrication for blanket and core, 17: 17591 (ANL-6107)
ARGONNE NATIONAL LAB., LEMONT, ILL.
personnel radiation exposure data for, analysis of, 17: 16312 (ANL-6688)
ARMY REACTORS (ML-1)
development of materials for, 17: 15532(R) (BMI-1607(Del.))
operation tests, 17: 17541(R) (IDO-28602)
ARMY REACTORS (SL-1)
accident, fast neutron dose estimates in, 17: 16315 (LADC-5359)
ARSENIC
photon elastic scattering at particle threshold energy, cross sections for, 17: 17153
ARSENIC ISOTOPES As-74
production in proton reactions (p,n) with germanium, mechanism for, 17: 17116 (JINR-P-1157)
production of, by 16-Mev cyclotron in Yugoslavia, 17: 17321
ARSENIC ISOTOPES As-75
nuclear spin levels in, in gallium arsenide crystals, 17: 17209
ARSENIC ISOTOPES As-76
production in proton reactions (p,xn) with germanium, mechanism for, 17: 17116 (JINR-P-1157)
ARSENIC ISOTOPES As-77
production in proton reactions (p,xn) with germanium, mechanism for, 17: 17116 (JINR-P-1157)
ARSENIC ISOTOPES As-78
production in proton reactions (p,xn) with germanium, mechanism for, 17: 17116 (JINR-P-1157)
ARSENIC OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
ARSONIC ACIDS
preparation of chromogenic, 17: 15860(R) (ORNL-3397(p.113-16))
ARTEREHOL
protective effects of, against radiation in mice, 17: 15826
ASCORBIC ACID
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668
radiation effects on synthesis in rat liver extracts, 17: 15656
radiation effects on content of, in *Vicia faba* seeds, 17: 15716
ASTROPHYSICS
atomic reactions in stellar atmospheres, 17: 16886
neutrinos in, 17: 16917
ATMOSPHERE
analysis for nuclear-explosion debris, 17: 16902
composition and energy relations of upper, 17: 16307
cosmic neutrons above, flux and energy spectrum of, 17: 16922
dynamical morphology of the aurora polaris, 17: 16293
effects of high-altitude thermonuclear explosions on, 17: 16297
effects of high-altitude thermonuclear explosions on, 17: 16298
ionization by radiations from nuclear explosions, 17: 16292
ionization density profile in magnetosphere, 17: 16294
perturbations by nuclear explosions, 17: 16901
perturbations by nuclear explosions, barographic, 17: 16904
polar cap absorption in, effects on h-f bands, 17: 16295
radioactivity, research program of AEC, 17: 16331 (TID-12616(Rev. 1))
ATMOSPHERES
atomic reactions in planetary and stellar, 17: 16886
dynamics of thermally radiating gas in rarefied, 17: 16250
ATOMIC BEAMS
ionization of neutral, inverted cascades in, 17: 17342 (UCRL-7115)
ATOMIC ENERGY
developments in, in India, 1962, 17: 15533(R) (NP-12645)
ATOMIC ENERGY COMMISSION
research program on atmospheric radioactivity, 17: 16331 (TID-12616 (Rev. 1))
ATOMIC EXPLOSIONS
detection and inspection of underground, on-site, 17: 16906
detection, at altitudes around 60,000 miles, 17: 16899
detection of atmospheric debris from, 17: 16902
detection of high-altitude, by lf and vlf methods, 17: 16900
detection of underground, seismographic, 17: 16905
detection, performance of radiochemical methods for, 17: 16903
detection, performance of microbarographic methods for, 17: 16904
detection, using ground-based stations, 17: 16901
earth motion from underground, 17: 16265 (PNE-111F)
effects and phenomena of, 17: 16330 (P-1951(RAND))
effects of high-altitude, on trapped-electron distributions, 17: 16875
effects of, on mental and physical state of survivors, 17: 15824
radionuclide fractionation in debris, logarithmic correlations, 17: 16306
uses of, bibliography on peaceful, 17: 15534 (TID-3522(Rev.6))
ATOMIC PHYSICS
error limits for electron density, spin density, and atomic form factors, 17: 16852
ATOMIC STRUCTURE

book: *Operator Techniques in Atomic Spectroscopy*, 17: 16907
calculations for atoms with 1*s* and 2*p* electrons, 17: 16823
ATOMS
radiation scattering by moving, frequency redistribution in, 17: 16973
reactions in planetary and stellar atmospheres, 17: 16886
reactions with binary solids, computer program for describing, 17: 16778 (GEMP-192)
structure of $1s2p$, $1s^22p^3$, and $1s^22p^5$ electron configurations in, 17: 16823
ATROPINE
radiation effects on toxicity of, on mice, 17: 15678
ATTAPULGITES
testing of, for use in organic reactor coolant purification, 17: 15849 (CRCE-1131)
AUGER ELECTRONS
spectra of, in intermediate coupling region, 17: 16810
AURORAL STORMS
cosmic electrons and photons from, 17: 16897
photometric observations on October 28, 1961, 17: 16302
AZO DYES
analytical use of arsenazo III for photometric determination of uranium, 17: 15931
analytical use of dibromarsenazo II for determination of thorium, 17: 15926

B

BACTERIA
localization of tritium-labeled DNA in, use of electron microscopy and radioautography for, 17: 15596
radiation effects on nucleic acid synthesis in *S. typhimurium*, 17: 15777
radiation effects on spores of *Bacillus anthracis* and *Bacillus cereus*, lethal, 17: 15718
radiosensitivity of *Shigella sonnei*, effects of surface tension of medium, 17: 15721
BACTERIOPHAGES
radiation effects on properties of, 17: 15790
radiation effects on, mechanism of, 17: 15791
radiation effects on, type-analysis of dose-effect and dose-survival of, 17: 15703
reactivation after irradiation, 17: 15790
BALANCES
design and calibration of ultramicro-, 17: 16552
BARBITURIC ACIDS
solvent properties for calcium and strontium, 17: 16055(R) (TID-18261 (p.71-2))
BARIUM
content of, in components of Canadian diet, 17: 15587 (CRER-1068)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
BARIUM CHROMATES
radiation damage in crystals, 17: 16753
BARIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
BARIUM ISOTOPES Ba-139
decay data, 17: 17298
BARIUM NITRATES
reactions of, with dinitrogen tetroxide and spectra of anhydrous, 17: 15995
BARIUM OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
BARIUM SULFATES
reactions with cristobalite, 17: 15986
BARLEY
radiation effects on translocation of nucleic acids and proteins in germinating, 17: 15775
BAROMETERS
performance of microbarographs for detection of nuclear explosions, 17: 16904
BEANS
radiation effects on ascorbic acid content in *Vicia faba* seeds, beta, 17: 15716
BEARINGS
bibliography on high-temperature, 17: 16169 (AD-282462)
development of gas-lubricated, for use in high-speed turbo-machinery, 17: 16182(R) (TID-18292)
elastohydrodynamic equations for, computer solutions to, 17: 16660 (TID-18252)
BELGIAN REACTOR-2
design description, 17: 17601
BENZENE
association constants of, with chloranil, deuterium isotope effects in, 17: 15991
benzene-cyclohexane, hydrogen yields in radiolysis of, 17: 15768
radioinduced reactions with carbon tetrafluoride, 17: 16121(P)
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)
radiolysis of, hydrogen yield in, 17: 15768
spectrum of crystalline monodeutero-, peculiarities in, 17: 16010(T)
BENZENE, ETHYL-
association constants of, with chloranil, deuterium isotope effects in, 17: 15991
BENZENE, TRINITRO-
spectra of triphenylamine complexes of, 17: 16785 (NYO-3062)
BENZENES, ALKYL-
preparation and properties, 17: 15860(R) (ORNL-3397(p.113-16))
BENZIMIDAZOLES
2-benzyl- and 5-6-dimethyl-, protective effects against ultraviolet radiation effects on mussel gills, 17: 15674(T)
BENZOIC ACID, *m*-NITRO-
analytical use of, for separation of scandium and thorium, 17: 15909
3,4-BENZOPYRENE
fluorescence, excitation by photons with energy less than photons emitted, 17: 16813
BERKELIUM
properties and chemical separation methods of, 17: 15972
BERYLLIUM
analysis for impurities by nonfilm radiation imaging, 17: 15890 (Y-1403)
atomic structures of $1s^22p^2$ electron configurations, 17: 16823
corrosion of, by rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
development as reactor moderator material, 17: 17445
extrusion of, to form twisted-rib tubing, 17: 16607(R) (NMI-4950)
fabrication process for, 17: 16618(P)
formation of components of, review of methods for, 17: 16614
metallurgical properties and uses of, 17: 16614
oxidation of, by carbon dioxide at high temperatures, 17: 16598
photoproton angular and energy distributions from, at 140 to 190 Mev, 17: 17295
precipitation of intermetallic phases in commercial, 17: 16691
reactions with uranium monocarbide at 700 to 1000°C, 17: 16537
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
spectra of, spin-orbit coupling in band structure, 17: 16845
spectrum of neutral atom of, ionization limit determined by, 17: 16808
BERYLLIUM ALLOYS
development as reactor moderator material, 17: 17445
Al–Be–Fe, structure of phases, 17: 16691
Be–Fe, magnetic properties of, 17: 16704
Be–Fe, structure of phases, 17: 16691
Be–Nb, development of, for high-temperature uses, 17: 16637(R) (BBC-115)
Be–Nb, oxidation of $NbBe_{12}$ and Nb_2Be_{17} at 1200 to 1800°F, 17: 15947(R) (DRI-2088)
Be–Pu, neutron yield from, 17: 16556
Be–Pu, phase diagram, 17: 16567
Be–Pu, preparation, 17: 16568
Be–Zr, development of, for high-temperature uses, 17: 16637(R) (BBC-115)
Be–Zr, oxidation of $ZrBe_{13}$ and Zr_2Be_{17} at 1200 to 1800°F, 17: 15947(R) (DRI-2088)
BERYLLIUM COMPACTS
formation of components of, review of methods for, 17: 16614
BERYLLIUM COMPOUNDS
carcinogenicity of inhaled, in animals, 17: 15835
BERYLLIUM FLUORIDES

carcinogenicity of inhaled, in animals, 17: 15835
crystal structure of, rhombic modification of, 17: 16673
BERYLLIUM ISOTOPES Be-7
energy levels of, from lithium-7 (p,n) reactions, 17: 17220
BERYLLIUM ISOTOPES Be-8
energy levels of, in lithium-7 (d,α) reactions, 17: 17223
BERYLLIUM ISOTOPES Be-9
alpha reactions (α,n), neutron angular distribution from, 17: 17154
deuteron reactions (d,p) on, knock-out mechanism in, 17: 17168
deuteron reactions (d,α) with, alpha angular distribution from, 17: 17245
electron decay, cross section, 17: 17144
energy levels of, in lithium-7 (d,α) reactions, 17: 17223
proton reactions(p,n), neutron polarization from, 17: 17125 (TID-18137)
BERYLLIUM NITRATES
effects of injected, on skin of guinea pigs, 17: 15598
reactions of, with dinitrogen tetroxide and spectra of anhydrous, 17: 15995
BERYLLIUM OXIDE COMPACTS
thermal conductivity of sintered, 17: 16248
BERYLLIUM OXIDES
analysis for lithium, flame photometric, 17: 15861(R) (ORNL-3397(p.117-21))
carcinogenicity of inhaled, in animals, 17: 15835
density and porosity of, method for determining, 17: 15954 (PG-Report-352)
development as reactor moderator material, 17: 17445
preparation and properties of, for electronics, 17: 16612
properties and uses of, mechanical and physical, 17: 16715
radiation and temperature effects on mechanical and physical properties of, 17: 16760
thermal conductivity at −200 to +150°C, effects of impurity, 17: 16681
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
BeO/Na_2O, effects of calcium, silicon, and strontium in, 17: 16002
BERYLLIUM PHOSPHATES
carcinogenicity of inhaled, in animals, 17: 15835
BERYLLIUM SULFATES
carcinogenicity of inhaled, in animals, 17: 15835
BETA DECAY
overlap and exchange effects in, 17: 17221
pair correlation effects on, near closed nuclear shells, 17: 17182
review, 17: 17309
systematics of, in heavy nuclei, 17: 17148
theory of, using exact electron radial wave functions, 17: 17177
BETA PARTICLES
atmospheric ionization by, from high-altitude explosions, 17: 16292
chemical effects on catalytic activity of calcium chloride in dehydration of cyclohexanol, 17: 16040 (BMI-1620)
detection and measurement of, in fluids, design of scintillation detector for, 17: 16482(P)
detection and measurement of, design of scintillation counter for, 17: 16430 (TRG-Report-464)
effects of, on ascorbic acid content in *Vicia faba* seeds, 17: 15716
effects of, on mitosis in rat skin, 17: 15694
effects of, on phosphorus-32 uptake by DNA and RNA in rat skin, 17: 15694
effects on development of plant cells, 17: 15653
lethal effects on yeasts, 17: 15793
reactions with gases, ion pair production in, 17: 16086
sorption of, by rat skin, protective effects of adrenaline and tannin against, 17: 15553
BETA SOURCES
activity measurements of, principles of coincidence method for, 17: 16439
therapy using, practical dosimetry in interstitial, 17: 15545
BETA SPECTROMETERS
design and performance of, for space uses, 17: 16892
performance, 17: 16353
BETATRONS
depth dose measurements of 6-Mev, for clinical use, 17: 15544
BIBLIOGRAPHIES
on activation analysis, 17: 15914
on chemical technology of metal complexes with oxy acids, 17: 15918
on correlation coefficients for 2-photon nuclear transitions, 17: 17286
on defense metals information, 17: 16523 (NP-12632)
on development of reactor fuel materials, 17: 17444
on development of reactor moderator materials, 17: 17445
on development of reactor materials for cladding and structural uses, 17: 17447
on developments in reactor materials technology, 17: 17442
on effects of fallout and radionuclides on wild and domestic birds, 17: 15635 (TID-17762)
on electron spin resonance in biological studies, 17: 15547
on fabrication of reactor materials by powder metallurgy, 17: 17443
on fission of rhenium and thorium by helium ions, 17: 17124 (TID-18131)
on friction, lubrication, and bearings, Jan. 1959 through Dec. 1961, 17: 16169 (AD-282462)
on giant resonances in photonuclear reactions, 17: 17284
on kinetic theory of nonequilibrium processes in gases, 17: 16864
on liquid metal technology, 17: 16535
on liquid metals technology, Sept. 1962 to Feb. 1963, 17: 16519 (LM-TAB-21)
on molybdenum, 17: 16549
on nuclear fissions involving low excitation energies, 17: 17283
on nuclear-reaction studies using pulsed accelerators, 17: 17282
on nuclear reactor control, kinetics, and stability, 17: 17420 (NAA-SR-7786)
on peaceful uses for nuclear explosives, 17: 15534 (TID-3522(Rev.6))
on radiation effects on solid uranium-based nuclear fuel materials, 1961 and 1962, index to, 17: 16747 (VDIT-16(Ind.61/62))
on separation of hexavalent uranium from aqueous solutions by anion exchange, 17: 16148 (VDIT-70)
on sintering of oxides, 17: 16534
on solid-state properties of bismuth and tellurium alloys and compounds, 17: 16655 (SB-62-62)
on stainless steel corrosion, 17: 16593 (VDIT-5a)
on structure of refractory materials, 17: 16666
on super-high-frequency electron fluxes, 17: 17388
on uranium extraction, 17: 16147 (VDIT-68)
on vibrational states of spherical nuclei, 17: 17285
on 1960 Russian international geophysical year literature, 17: 16266(T) (NASA-TT-F-109)
BIG ROCK POINT POWER REACTOR
fuel rod vibration in parallel flow in, 17: 17537 (GEAP-4059)
BIOCHEMISTRY
applications of isotope effects in studies of, 17: 15554
BIOLOGICAL SYSTEMS
radiation effects on, application of target theory to, 17: 15708
BIOPHYSICS
of biological effects of radiation, 17: 15701
BIPHENYL
molecular structure, theory of carbon-carbon bonds in, 17: 16031(R) (TID-17275)
BIRDS
radiation effects on populations, 17: 15635 (TID-17762)
BISMUTH
alloying effects on titanium, 17: 16580(P)
analysis of, for impurities, activation, 17: 15919
neutron elastic low-angle scattering at 14.2 Mev, 17: 17097
photon elastic scattering at particle threshold energy, cross sections for, 17: 17153
solvent properties for plutonium and uranium, 17: 16574
BISMUTH ALLOYS
solid-state properties of, bibliography on, 17: 16655 (SB-62-62)
Bi_4Gd_3, ferromagnetism of, 17: 16670
Bi–Pu, phase diagram, 17: 16567
BISMUTH ISOTOPES Bi-209
electron inelastic scattering by, 17: 17233
fission by boron-11, carbon-12, nitrogen-14, and oxygen-16 ions, distributions from, 17: 17225
proton fission at 20 Bev, 17: 17180
reactions with carbon-12 and oxygen-16, compound nucleus formation cross sections for, 17: 17118 (JINR-P-1162)
BISMUTH ISOTOPES Bi-210
beta decay of, shell model analysis, 17: 17166

separation from ethylenediamine acetate solutions, electrolytic and chemical, 17: 16150(T) (CEA-tr-A-1291)
BLACK SEA
uranium content in, 17: 16276
BLADDER
radiation injuries, treatment using Albothyl instillation, 17: 15710
BLAST EFFECTS
from nuclear explosions, analysis of, 17: 16330 (P-1951(RAND))
BLOOD
coagulation in radiation sickness, effects of bone marrow proliferation on, 17: 15837
effects of cooling to 0–5°C on, in rats, 17: 15796
flow measurement in brain, tracer technique, 17: 15580
irradiation, extracorporeal, effects on formed elements and serum proteins, 17: 15639(R) (TID-18194)
radioinduced changes in, effects of cysteamine on, 17: 15796
BLOOD CELLS
cesium and potassium contents in, 17: 15621
counts of, distributional method for evaluating, 17: 15846
BLOOD CIRCULATION
in liver, tracer studies, 17: 15543 (UCLA-511)
BLOOD COAGULATION
effects of estrogen, testosterone, vitamin K, and methionine in rats, 17: 16364(R) (NP-12602)
effects of irradiated beef diet, in rats, 17: 16360(R) (NP-12597)
BLOOD DISEASES
radiodiagnosis of anemias, 17: 15549
BLOOD PICTURE
in bomb survivors in Fukuoka and Saga Perfectures, 17: 15828
radiation effects, extracorporeal exposure, 17: 15639(R) (TID-18194)
radiation effects from iodine-131 injected for therapy of thyroid tumors, 17: 15696
BLOOD PLASMA
radiation effects on amino acid levels in, 17: 15784
radiation effects on corticosterone synthesis in, in rats, 17: 15808
BLOOD SERUM
radiation effects on hemagglutinin in, by influenza virus, 17: 15668
radiation effects of plutonium-239 on albumen levels in, 17: 15741
radiation effects on composition of proteins in, 17: 15770
BODY FLUIDS
excretion of sodium in sweat, tracer study, 17: 15700
BOILERS
design, 17: 16258(P)
design of, 17: 16255(P)
evaluation of spiral, for SNAP 2 program, 17: 16227 (NAA-SR-Memo-7945)
BOILING
burnout in reactor fuel rod clusters, 17: 16238
burnout in, studies of critical, 17: 16237(T,R) (EURAEC-523)
flow regimes in, two-phase, 17: 16235 (WAPD-T-1566)
nucleate in Santowax OM, effects of dissolved nitrogen on, 17: 16228 (NAA-SR-Memo-8064)
of water from outer surface of tubes for natural and forced convection, design of system for studying, 17: 16231(R) (TID-15719)
vapor carry-under in vapor-liquid separation by gravity, 17: 16240
BOILING REACTORS
control of, development of hydraulic-ball system for, 17: 17412(R) (GNEC-264)
design concepts for 300 Mw high-power-density, 17: 17535 (GEAP-3967)
design of 600-Mw(e) boiling water–separate superheat, 17: 17536 (GEAP-4057)
development of Garigliano for increased power output, 17: 17539(R) (GEAP-4164)
dynamic behavior of, lectures on, Netherlands-Norwegian Reactor School, Kjeller, Norway, Aug. 20 to 31, 1962, 17: 17417 (KR-35 (Vol.I))
dynamic behavior of, lectures on, Netherlands-Norwegian Reactor School, Kjeller, Norway, Aug. 20 to 31, 1962, 17: 17418 (KR-35 (Vol.II))
dynamics, effects of ship motion, 17: 17578
fuel burnup in, nuclear changes during, 17: 16739 (GEAP-4107)
stabilization, control system for, 17: 17590(P)
vapor removal from core of, method for, 17: 17520(P)
BOLTS AND NUTS
mechanical properties of Inconel x at 1100°F, 17: 17411(R) (GEMP-177C)
BONDS
theory of carbon-carbon, in polyphenyls, 17: 16031(R) (TID-17275)
BONE MARROW
chromosomal aberrations in irradiated and non-irradiated, effects of DNA on, 17: 15788
function test of, in bomb survivors in Fukuoka and Saga Perfectures, 17: 15828
gold-198 distribution in, after intracardiac injections in rats, 17: 15607
infusions, effectiveness against toxic effects of tris(1-aziridinyl) phosphine sulfide in mice and dogs, 17: 15548
infusions of, following whole-body radiotherapy of leukemic patients, 17: 15546
protective effects of, with spleen cells against lethal radiation in dogs, 17: 15814
protective effects of, against lethal radiation in dogs, technique for preparation of suspensions for, 17: 15845
radiation effects on, direct and indirect, 17: 15769
radiation effects on aspiration of, 17: 15820
radiation effects on methionine synthesis in rabbit, 17: 15843
reticulo-endothelial system in, activity demonstration using gold-198 colloids, 17: 15715
therapeutic effects of transplanted, on radiation sickness, 17: 15837
therapeutic effects on irradiated guinea pigs, 17: 15839
transplantation of, effects of, on leukemia in irradiated mice, 17: 15724
treatment of radiation injuries with autologous, 17: 15821
BONES
binding of yttrium, effects of various chelating compounds on removal, tracer study, 17: 15567
calcium metabolism by, following irradiation, effects of denervation on, 17: 15755
cesium, potassium, and rubidium content in, in man, 17: 15603
radiation effects of intravenous injections of plutonium-239, radium-226, and strontium-90 on, 17: 15847
strontium-90 content in "hot zones" in, 17: 15606
BORON
determination in magnesium, absorptiometric method for, 17: 15881 (PG-Report-409)
neutron-shielding performance of, 17: 16731(P)
photoproton angular and energy distributions from, at 140 to 190 Mev, 17: 17295
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
BORON CARBIDES
neutron-shielding performance of, 17: 16731(P)
properties as reactor control material, tests of, 17: 16737 (GEAP-3927)
use in uranium dioxide fuel elements as burnable poison, 17: 16605(R) (CEND-173)
Al_2O_3–B_4C, burnup, effects of boron-10 on, 17: 15532(R) (BMI-1607 (Del.))
BORON COMPOUNDS
properties of, for use in therapy of brain tumors, 17: 15575
BORON CRYSTALS
preparation and structure of high-purity single, 17: 16635 (ASD-TDR-62-427)
BORON FLUORIDES
krypton-ion reactions at 30 kev, production of fluorine ion beams in, 17: 17253
BORON ISOTOPES B-10
burnup in alloy dispersions, 17: 15532(R) (BMI-1607(Del.))
deuteron reactions (d,p) on, knock-out mechanism in, 17: 17168
helium-3 reactions (He^3,n), cross sections for 2.0 to 6.3 Mev, 17: 17236
BORON ISOTOPES B-11
fission of bismuth-209 and gold-197 by, 17: 17225
BORON ISOTOPES B-12
angular distribution and polarization of, from meson (μ^-) capture by carbon-12, 17: 17117 (JINR-P-1160)
beta decay of, branching ratio and half life for, 17: 17236
beta spectra of, test for conserved vector current theory with, 17: 17237
BORON NITRIDES

neutron-shielding performance of, 17: 16731(P)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
BORON OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
heat of vaporization, 17: 15944 (AROD-006.7)
BORON SYSTEMS
B–Cr–Ti, phase studies of, 17: 16711
BOSONS
interactions with baryons, mass splitting in strong and weak, 17: 17016
mass of, 17: 17375
production of intermediate vector, possibility for copious, 17: 17036
quantum statistical mechanics of negative-energy, 17: 16998
Regge trajectories for, 17: 17032
theory of, functional integrals in formulation of, 17: 17066
BRAIN
blood flow measurement in, tracer technique, 17: 15580
radiation effects on glycogen content and vascular permeability of, in rats, 17: 15695
radiation effects on, after resection of cervical sympathetics, 17: 15844
visual observation of, in sheep, 17: 15541(R) (ORO-598)
BRAIN TUMORS
therapy of, properties of boron compounds for, 17: 15575
BRAZING
methods for refractory alloys, exothermic, 17: 16608(R) (NP-12615)
BRAZING ALLOYS
composition and properties for exothermic bonding, 17: 16608(R) (NP-12615)
BREEDER REACTORS
design of mixed-oxide plutonium-fueled, 17: 16576
development at ANL, review, 17: 16555
fuel element design for, 17: 17482(P)
BREMSSTRAHLUNG
interactions with protons, photoproduction of mesons (η^0) in, 17: 16987
internal spectrum for beta-decaying calcium-45, 17: 17260
reactions (γ,p) with sulfur-32 at 24 Mev, proton energy spectrum from, 17: 17155
reactions with hydrogen at 160, 170, and 185 Mev, meson (π^0) production in, 17: 17082
reactions with nuclei at high energies, cross sections for pair-production, 17: 17105 (DESY-A-2.96)
BROMIDES
effects of soil treatment with methyl, on uptake of iodine-131 by pine trees, 17: 15735
BROMINE
oxidation of aldehydes by, deuterium isotope effects in, 17: 16037
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
BUBBLE CHAMBERS
data analysis system for, digital computer, 17: 16419 (BNL-6871)
photographs of events, design of instrument for scanning and measurement, 17: 16460
BUILDING MATERIALS
analysis of, for water content in, by thermal neutron diffusion method, 17: 15902
for nuclear power plants, review on, 17: 17583
BURROS
radiation injuries, pathology, 17: 15541(R) (ORO-598)
BUTADIENE
radioinduced graft polymerization to textiles, 17: 16041(R) (NCSC-2477-10)
BUTANE, 2-METHYL-
photochemical reactions with iodine, 17: 16038
1-BUTANOL
heat transfer from forced-convection boiling, in tubes, 17: 16234 (UCRL-10527)
BUTYL PHOSPHATES
solvent properties for uranium, effects of nickel arsenides on, 17: 16144 (NLCO-867)
solvent properties for uranium, 17: 16145 (ORNL-3312)
solvent properties for reactor fuels, research on, 17: 16146 (ORNL-TM-527)
solvent properties for fission products, plutonium, and uranium, 17: 16158
solvent properties for thorium, 17: 16161
solvent properties for thorium, 17: 16162
solvent properties for hafnium and zirconium, mathematical analysis of, 17: 16165
solvent properties for hafnium, 17: 16166
TBP-kerosene, analysis for uranium by x-ray fluorescence, 17: 15883 (PG-Report-428)

C

CABLES
passage into reactor vessel, leading-in plate for, 17: 17512(P)
CADMIUM
magnetoplasma resonance in, 17: 16841
neutron elastic scattering by, 17: 17094 (TID-18277)
neutron scattering at 0.45 Mev, differential cross section and polarization in, 17: 16770(R) (ANL-6666)
neutron-shielding performance of, 17: 16731(P)
oxidation of, nucleation-germination phenomena in, 17: 16596(T,R) (EURAEC-559)
photon elastic scattering at particle threshold energy, cross sections for, 17: 17153
separation from silver by electrolytic methods, 17: 15912
spectra of, spin-orbit coupling in band structure, 17: 16845
CADMIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
CADMIUM ISOTOPES Cd-115
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
sorption of, by lithium halide cation exchange resins, 17: 15992
CADMIUM SULFIDE CRYSTALS
alpha reactions with, effects of electrode contacts on pulses induced by, 17: 16092
preparation with interstitial atoms, 17: 16581(P)
CALCINATION
demonstration of pot, design of pilot plant for, 17: 17616 (IDO-14596)
process development for radioactive wastes, 17: 17615(R) (HW-76262)
CALCIUM
content of, in components of Canadian diet, 17: 15587 (CRER-1068)
isotopic exchange in soils, 17: 15581
luminescent effects of, on uranium, 17: 15928
metabolism by skeleton following irradiation, effects of denervation on, 17: 15755
precipitation from solutions containing cations, use of dilituric acid in, 17: 16055(R) (TID-18261(p.71-2))
reactions with sodium beryllate solutions, 17: 16002
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
CALCIUM CHLORIDES
radiation effects on catalytic activity in dehydration of cyclohexanol, 17: 16040 (BMI-1620)
CALCIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
CALCIUM FLUORIDE CRYSTALS
spectra of divalent samarium containing, Zeeman effect in absorption and luminescence, 17: 16011(T)
spectra of divalent samarium containing, deformation splitting of lines in, 17: 16012(T)
spectra of divalent europium containing, deformation splitting of lines in, 17: 16012(T)
CALCIUM FLUORIDES
development of manganese-activated, for dosimeter phosphors, 17: 16416(R) (AD-283918L)
radiation effects of neutrons on, nuclear magnetic resonance studies of, 17: 16111
CALCIUM ISOTOPES
alpha reactions (α,γ), resonance in, 17: 16916
CALCIUM ISOTOPES Ca-40
alpha reactions (α,pn), 17: 17218
bremsstrahlung reactions (γ,p) at 24 Mev, cross sections for, 17: 17155
helium-3 reactions, 17: 17218
CALCIUM ISOTOPES Ca-42

energy levels and spins of, 17: 17218
CALCIUM ISOTOPES Ca-45
distribution of, in *Phaseolus vulgaris* L. during seed germination and young plant development, 17: 15551
internal bremsstrahlung accompanying β decay of, 17: 17260
uptake by *Gammarus lacustris*, 17: 15623
CALCIUM ISOTOPES Ca-47
uptake of, by skeleton in normal and rachitic rats, 17: 15591
CALCIUM NITRATES
reactions of, with dinitrogen tetroxide and spectra of anhydrous, 17: 15995
CALCIUM OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
CALCIUM PHOSPHATE CRYSTALS
luminescence spectra of sensitized, 17: 16088
CALCIUM PHOSPHATES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
CALCIUM SULFATES
reactions with cristobalite, 17: 15986
CALCIUM TITANATES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
CALIFORNIUM
properties and chemical separation methods of, 17: 15972
CANADA
radiobiology research projects, 1962 and 1963, 17: 15627 (CRB-1129)
CANDU REACTOR
development of, AEC/AECL cooperative program for, 17: 17546(R) (SRO-80)
refueling system, design and development of on-power, 17: 17532 (AMF-388-TR-2(Vol.I))
refueling system, graphic coverage of design features, 17: 17533 (AMF-388-TR-2(Vol.II))
CARBIDES
development of, for thermionic space reactors, 17: 16516(R) (GA-3866)
CARBON
additive effects on titanium, 17: 16580(P)
content and carburization potential of, in SRE sodium, 17: 17597 (NAA-SR-Memo-7804)
determination in aqueous nitric acid by combustion, 17: 15855(R) (ORNL-3397(p.38-54))
deuteron scattering at 420 Mev, angular distribution, tensor and vector polarizations for, 17: 17122 (PUC-1962-78)
development of pyrolytic for fuel coating, 17: 15532(R) (BMI-1607(Del.))
meson (π^-) reactions at 7 Bev, meson (η) radiative decay in, 17: 17119 (JINR-P-1164)
neutron elastic scattering and polarization by, at 2.8 Mev, 17: 17294
photoproton angular and energy distributions from, at 140 to 190 Mev, 17: 17295
production of low-permeability, 17: 16578(P)
proton scattering at 28 Mev, polarization in elastic and inelastic, 17: 17198
radiation and temperature effects on mechanical and physical properties of, 17: 16760
reactions of recoil, with ethylene, ethylene oxide, and isobutane, effects of phase on, 17: 16078
reactions with uranium dioxide in arcs, production of uranium carbides by, 17: 16029(P)
CARBON ARCS
plasma fuel ion heating by magnetically confined, 17: 17333(R) (ORNL-3392(p.47-8))
CARBON DIOXIDES
determination of, in uranium fission products, 17: 15892
effects on calibration of thermocouples, 17: 16526 (ORNL-TM-481)
oxidation of beryllium by, at high temperatures, 17: 16598
oxidizing effects on purified graphite, 17: 15966(T) (NP-tr-958)
oxygen-18 exchange, radioinduced, 17: 15976
reactions with uranium trioxide in aqueous solution, 17: 15969
reactions with uranium powder, mechanism, 17: 15980
sticking factors for, on titanium film, 17: 17337(R) (ORNL-3392 (p.86-8))
CARBON FILMS
electron energy loss in, 17: 15765
graphitization and deformation, electron microscopic studies, 17: 16692
CARBON ISOTOPES C-12
alpha reactions (α,n), neutron angular distribution from, 17: 17154
alpha reactions (α,p), proton angular distribution from, 17: 17154
alpha reactions (α,p), backward peaks in angular distributions from, 17: 17188
alpha reactions ($\alpha,\alpha'\gamma$) and (α,pγ), particle-gamma coincidence studies of, 17: 17290
bremsstrahlung reactions (γ,p) at 24 Mev, cross sections for, 17: 17155
deuteron reactions(d,n), neutron polarization from, 17: 17125 (TID-18137)
deuteron reactions (d,p) on, knock-out mechanism in, 17: 17168
deuteron reactions (d,α) on, angular distributions from, 17: 17171
deuteron reactions (d,n) with, polarization of neutrons from, 17: 17264
electron (+ and −) elastic scattering by, models for, 17: 17186
energy levels, effects on giant resonance of dipole, 17: 17160
fission of bismuth-209 and gold-197 by, 17: 17225
meson (μ^-) capture by, polarization of boron-12 ground state in, 17: 17117 (JINR-P-1160)
neutron reactions (n,α) at 14 Mev, mechanism of, 17: 17288
proton fission (p,p'3α), mechanism for, 17: 17174
reactions (C^{12},3n) with tellurium-128, cerium-137 isomeric cross section ratios from, 17: 16054(R) (TID-18261(p.61-70))
reactions with nuclei, compound nucleus formation cross sections for, 17: 17118 (JINR-P-1162)
reactions with tellurium-128, isomeric cross section ratios for neutron-transfer, 17: 16050(R) (TID-18261(p.24-6))
CARBON ISOTOPES C-14
content in thymol from essential oils, annual variation, 17: 15618
detection and measurement using liquid scintillation counters, 17: 16457
detection and measurement, effects of sample-holder material on, 17: 16458
incorporation into glycyl-dipeptides, 17: 16035
CARBON MONOXIDES
effects on calibration of thermocouples, 17: 16526 (ORNL-TM-481)
proton reactions on, ionization cross sections in, 17: 16886
sticking factors for, on titanium film, 17: 17337(R) (ORNL-3392 (p.86-8))
CARBON SYSTEMS
C–Fe–Pu, use as reactor fuel, 17: 16577(P)
C–Hf–Fe, phase studies, 17: 16542
C–Hf–Nb–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–Nb–Ta–V–Zr, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–Nb–Zr–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–O–U, phase studies, 17: 16522(R) (NCSC-2663-10)
CARBON TETRACHLORIDE
dilution effects of, on proton magnetic resonance of phosphoric acid esters, 17: 16034 (TID-18170)
stimulative effect in induction of tumors by radiation exposure, 17: 15643 (USNRDL-TR-396)
CARBON TETRAFLUORIDE
determination in reactor test capsules, chromatographic, 17: 15855(R) (ORNL-3397(p.38-54))
radioinduced reactions with benzene, 17: 16121(P)
CARBONYL COMPOUNDS
radioinduced in animal tissues, properties, 17: 15631 (NP-12601)
CARCINOGENESIS
from soft x rays on mice, 17: 15823
CARCINOGENS
of beryllium compounds inhaled by animals, 17: 15835
CARCINOMAS
pathological effects of radium dial paints on, epidemiological follow-up of, 17: 16342
radiosensitivity of, effects of β-(2-aminoethylisothiouronium) and serotonin on, 17: 15747
radiotherapy, chemical sensitization, 17: 15669
radiotherapy of cervical, effects of, on rectum and sigmoid colon, 17: 15807
radiotherapy of pulmonary, effects of direct, 17: 15830
CAROLINAS-VIRGINIA TUBE REACTOR

pressure tubes, irradiation testing, 17: 16734 (CVNA-159)
testing, 17: 17546(R) (SRO-80)

CATALYSTS
geometrical factor of metal, in deuterium exchange between p-xylene and water, 17: 15863
regeneration of alkyl-amide, 17: 16500(P)

CATARACTS
radioinduced, characteristics of, 17: 15717

CATHODES
emission of carbide, 17: 16516(R) (GA-3866)
vaporization of carbide, physical and chemical redeposition methods for reduction of, 17: 16774(R) (GA-3642)

CATTLE
fission product metabolism, 17: 15541(R) (ORO-598)
radiation injuries, pathology, 17: 15541(R) (ORO-598)

CAVITATION
in mixed-flow pump impellers, 17: 16244
of underground salt domes, 17: 16179(R) (TID-18074)
performance variations in stationary and rotating components, 17: 16243

CEMENTS
content in finished concrete, use of neutron source for measurement of, 17: 15901

CENTRIFUGES
ultra-, rotational energy losses in, 17: 16197

CERAMIC MATERIALS
development and properties of, containing rare earths for reactors, 17: 17434
radiation and temperature effects on mechanical and physical properties of, 17: 16760

CERIUM
content of, in marine organisms, 17: 15604
determination by electrometric titration using molybdate, 17: 15997
determination of, in lanthanum oxide, spectrographic, 17: 15932
determination of, luminescent, 17: 15928
determination of, using sodium molybdate, amperometric, 17: 15907
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)

CERIUM ALLOYS
Ce–Ni, effect of annealing on coercive force of deformed, 17: 16716

CERIUM BORIDES
optical properties of hexa-, 17: 16714(T)

CERIUM CARBONATES
preparation by precipitation, 17: 15951 (LADC-5579)
thermal decomposition of, compound formations in, 17: 15951 (LADC-5579)

CERIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001

CERIUM(III) IONS
reactions with molybdate, electrometric studies, 17: 15997

CERIUM ISOTOPES Ce-137
isomeric yields of, from cerium-140, 17: 16054(R) (TID-18261(p.61-70))

CERIUM ISOTOPES Ce-138
isomeric transitions, 17: 17147

CERIUM ISOTOPES Ce-140
energy levels of, configuration assignment and gyromagnetic ratio for 2.083 Mev, 17: 17194

CERIUM ISOTOPES Ce-144
distribution in soil from weapons tests, 17: 16288
uptake by *Gammarus lacustris*, 17: 15623

CERIUM OXIDES
effects of, on magnetic properties of magnesium manganese ferrates, 17: 16019
fabrication by vibratory compaction, 17: 16609(R) (NYO-10214)
separation from rare earth ores, process for, 17: 16130(P)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)

CESIUM
adsorption on metals, mechanics of, 17: 16769(R) (AI-7979)
content in blood cells of rabbits, 17: 15621
content of, in bone, muscles, and soft tissues in man, 17: 15603
content of, in Pacific Ocean and sewage plant from fallout, 17: 16299
determination in animal tissue and river water, flame photometric, 17: 15857(R) (ORNL-3397(p.57-70))
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
electric charge of neutral, upper limits for, 17: 17012
plasma of, field reversal in tenuous, 17: 16790 (TID-18216)
sorption on tungsten, thermal accommodation of rare gases during, 17: 16027
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)

CESIUM BORATES
spectra in vapor, infrared, 17: 15945 (AROD-006.8)

CESIUM BROMATES
spectra of irradiated, infrared, 17: 15862(R) (ORNL-3397(p.121-3))

CESIUM IONS
hollow-beam development for rocket engines, 17: 17604(R) (N62-11122)
production in propulsion motors, 17: 16873
scattering by molybdenum target, energies of, 17: 17257

CESIUM ISOTOPES Cs-137
content in body, measurements of, in Federal Republic of Germany, January to March 1962, 17: 15624
content in Norwegian milk during 1961, 17: 15614 (A/AC.82/G/L.810)
content of, in eastern Pacific Ocean off California coast, variations in, 17: 16300
content of, in human urine, estimation of body burden from, 17: 16343
distribution in soil from weapons tests, 17: 16288
effects of, on spermatogenesis in rats, 17: 15704
gamma dosimetry for field plant irradiation source, 17: 15732
gamma emission by, radiographic intensification of, 17: 17394
gamma spectra, 17: 16438
gamma spectra, radiographic intensification of, 17: 17394
separation from fission-product concentrates by ion exchange on ammonium molybdophosphate and zirconium phosphate, 17: 16139 (AERE-R-4245)
uptake by animals and humans under natural condition, 17: 16304

CESIUM OXIDES
thermal decomposition at 280 to 360°C, 17: 16026

CESIUM SULFIDES
semiconductor properties, 17: 16775(R) (GACD-2813)

CHARGED PARTICLE BEAMS
currents in, noninterrupting method of measuring, 17: 16792(R) (TID-18258)
focusing in cylindrically symmetric magnetic field proportional to r^{-1}, 17: 16387
space charge effects in circular accelerator, treatment of nonlinear azimuthal, 17: 17314 (MURA-654)

CHARGED PARTICLES
escape from plasma in magnetic field, 17: 17379
excitation of nuclei by slow, cross section for, 17: 17267
motion of trapped, in magnetosphere, 17: 16921
shielding against, electrostatic, 17: 17395

CHEMICAL PROPHYLAXIS
effectiveness of various compounds in, 17: 15841

CHEMICAL RADIATION DETECTORS
performance of nitrous oxide dosimeter, 17: 16441

CHEMICALS AND REAGENTS
spectra of, for photometric determination of zirconium, 17: 15927

CHEMISTRY
research in nuclear, 17: 16046(R) (TID-18261)

CHERENKOV DETECTORS
performance for measuring particle velocities, 17: 16453

CHERENKOV RADIATION
emission by electron beam of finite thickness, "leaky wave" analysis of, 17: 17081
emission by plasma oscillations, 17: 17341 (TID-18225)
use in reactor power measurements during impulse, 17: 17431

CHIMERAS
immunological tolerance in mouse radiation, 17: 15759

CHLORANIL
association constants of, with methylbenzenes, deuterium isotope effects in, 17: 15991

spectra of perylene complexes of, 17: 16785 (NYO-3062)
spectra of triphenylamine complexes of, 17: 16785 (NYO-3062)
CHLORIDE IONS
protective effects against radiation in DNA solutions, 17: 15792
CHLORINE
reactions with fission-product zirconium-97 in gas mixtures, 17: 16065
CHLORINE ISOTOPES Cl-35
deuteron reactions at 20 Mev, cross sections for, 17: 17216
CHLORINE ISOTOPES Cl-36
exchange of, between metal and nitrosyl and phosphoryl chlorides, 17: 15996
CHROMATOGRAPHIC SEPARATIONS
of polyphosphates, 17: 15885 (TID-18119)
CHROMATOGRAPHY
gas, ionization detector for, 17: 16396(P)
paper chromatograms in, design of rate meters for radioassay of, 17: 16450
CHROMIUM
alloying effects on titanium, 17: 16580(P)
determination in neptunium by ion exchange and spectrography, 17: 15896
determination of, in uranium fission products, 17: 15892
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
CHROMIUM ALLOYS
Al–Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Cr–Fe–Ni–Ti, precipitation processes in, 17: 16718
Al–Cr–Fe–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Cr–Ti, transformation behavior in, during cooling, 17: 16721
Cr–Fe, diffusion of fission products in and release from, 17: 16638 (BMI-1611)
Cr–Fe, radiation effects on, 17: 16541
Cr–Fe, tensile properties, 17: 16640 (DMIC-Memo-164)
Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Cr–Fe–Ni, corrosion of, by steam at 1050°F, 17: 16587 (GEAP-4165)
Cr–Fe–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Cr–Fe–Pu, fabrication for high-temperature fuels, 17: 15532(R) (BMI-1607(Del.))
Cr–Fe–Zr, phase studies, 17: 16545
Cr–Nb–Ti, phase studies, 17: 16543
Cr–Pu, phase diagram, 17: 16567
Cr–U, phase transformation curves of, tempered from β region, 17: 16671
Cr–V, electronic specific heat, 17: 16698
Cr–V, nuclear magnetic resonance, 17: 16820
CHROMIUM CARBONYLS
proton magnetic resonances of, 17: 15962 (TID-18199)
CHROMIUM ISOTOPES Cr-50
proton inelastic scattering at 6.9 Mev, angular distributions for, 17: 17266
CHROMIUM ISOTOPES Cr-51
distribution of, among components and polypeptide chains of hemoglobin, 17: 15593
incorporation of, into colloidal complex, 17: 15714
CHROMIUM ISOTOPES Cr-52
proton inelastic scattering at 6.9 Mev, angular distributions for, 17: 17266
CHROMIUM ISOTOPES Cr-54
proton inelastic scattering at 6.9 Mev, angular distributions for, 17: 17266
CHROMIUM OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
CHROMIUM SYSTEMS
B–Cr–Ti, phase studies of, 17: 16711
Cr–Mo–Si, oxidation resistance properties as coatings for niobium alloys, 17: 16633(R) (AD-296341)
Cr–Si–Ti, oxidation resistance properties as coatings for niobium alloys, 17: 16633(R) (AD-296341)
Cr–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
CHROMOSOMES
aberrations in irradiated and non-irradiated, effects of DNA on incidence of, 17: 15788
radioinduced translocations in spinach, 17: 15682
radiosensitivity in seeds during germination, 17: 15650
CINNAMIC ACID
analytical use of, for separation of gallium and indium from metals, 17: 15924
CIRCUITS
design for indicating reactor control rod positions, 17: 17485(P)
design of analog-to-digital converters, 17: 16879
CLINCH RIVER
radioactivity of, Aug. to Oct. 1962, 17: 17619(R) (ORNL-TM-482)
CLOUD-ION CHAMBERS
parameters affecting operating conditions and principal faults of, 17: 16442
COAL
radiation effects, 17: 16108
COATINGS
development and evaluation of, for protection of refractory materials against oxidation, 17: 16520 (MAB-189-M)
development for fuel elements, 17: 17447
development of alumina, beryllia, and carbon, for fuel particles, 17: 15532(R) (BMI-1607(Del.))
fabrication techniques for fuel element, 17: 17448
properties of niobium–zirconium alloys for use as, in BWR environments, 17: 16586 (GEAP-4098)
protective effects against oxidation of niobium alloys at 2600°F, 17: 16633(R) (AD-296341)
radiation effects on organic, 17: 16105
removal of epoxy from contaminated surfaces, 17: 16332(R) (UCRL-7143)
COBALT
alloying effects on titanium, 17: 16580(P)
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
neutron capture gamma spectra, 17: 17255
preparation of bentonite systems of, for radioinduced production of cobalt-60, 17: 16356(R) (ARF-1207-9)
reactivation effects on erythropoiesis in whole-body irradiated rats, 17: 15810
separation of, from indium and gallium using cinnamic acid, 17: 15924
COBALT ALLOYS
decontamination, noncorrosive solution for, 17: 15869(P)
electronic structure, 17: 16700
Co–Pu, crystal structure of Pu_2Co, 17: 16647 (LADC-5363)
COBALT COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
COBALT(III) COMPLEXES
reactions of iodopentammine-, with oxidation-reduction reagents, 17: 15987
COBALT IONS
magnetic relaxation in zinc lanthanum nitrates, 17: 16014
COBALT ISOTOPES Co-59
electron (+ and –) elastic scattering by, models for, 17: 17186
magnetic relaxation in zinc lanthanum nitrates, 17: 16014
proton reactions (p,n) on, spectra from, 17: 17226
COBALT ISOTOPES Co-60
gamma dosimetry for field plant irradiation source, 17: 15732
gamma spectra, radiographic intensification of, 17: 17394
preparation of high specific-activity, 17: 16356(R) (ARF-1207-9)
COBALT OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
COBALT THIOCYANATE COMPLEXES
analytical use of, for determination of tertiary alkyl amines, 17: 15906
COINCIDENCE CIRCUITS
design of, for detecting low energy gamma coincidences, 17: 16426 (ISS-62/26)
COINCIDENCE COUNTERS
design for delayed, for assay of radon-219 and radon-220, 17: 16440
design of nanocard logical modules, 17: 16470
particle losses through scattering in square telescopes, 17: 16422 (ISS-62/4)

COINCIDENCE MEASUREMENTS
design of shielded sample changer for, 17: 16445
COLLIMATORS
testing aluminum, for 20-Bev electron beam, 17: 17315 (ORNL-TM-524)
COLLOIDS
development of radioactive for therapeutic uses, 17: 15800
COMBUSTION
of metals, methods for determination of impurities by, 17: 15933
COMMUNICATION SYSTEMS
effects of polar-cap absorption on h-f bands, 17: 16295
COMMUNICATION THEORY
electromagnetic-signal distortion by media, 17: 16890
COMPRESSIBLE FLOW
magnetohydrodynamic, nonisentropic perturbations of, 17: 16510
COMPTON EFFECT
on bound electrons and protons, 17: 16780(R) (ISS-62/23)
COMPUTER PROGRAMS
development of Monte Carlo, for reactor analysis, 17: 17411(R) (GEMP-177C)
for calculating counter and crystal settings for collection of crystallographic data, Fortran for IBM 1620, 17: 15936 (AAEC/TM/179)
for calculating first order nucleon-nucleus optical potential on IBM 709, 17: 17123(R) (TID-18127)
for calculating third order effects in Coulomb excitation, 17: 17123(R) (TID-18127)
for calculation of roots of n-degree polynomial, IBM 610, 17: 16425 (ISS-62/11)
for data processing for Project Rover tests, 17: 16504 (LAMS-2845)
for describing atom bombardment of binary solids with square planar lattice, IBM 7090, 17: 16778 (GEMP-192)
for determining free-radical reactions after irradiation of aqueous solutions, 17: 16502 (ANL-6560)
for direct iteration solution of elastohydrodynamic equations, 17: 16660 (TID-18252)
for energy-spectrum analysis and for containment zones in DCX-1, 17: 17335(R) (ORNL-3392(p.56-65))
for nonlinear azimuthal space charge effects in circular accelerators, 17: 17314 (MURA-654)
for selecting neutron or x ray diffraction techniques in study of crystal structure, 17: 16767 (AAEC/TM-180)
for stress analysis of beam structures loaded by forces in plane of structure, 17: 16173 (KAPL-M-JVM-4)
FORTRAN for IBM-709 study of transmisstion of beam of primary particles, through linear magnetic system, 17: 16944 (CERN-62-36)
FORTRAN IBM-704, for calculations of radiation dose from inhaled or injected radioisotopes, 17: 16311 (AHSB(RP) R-20)
FORTRAN SNG, plane and spherical geometry, for 709, 17: 16507 (TID-18116)
HYTHEST, for hot spot calculations, 17: 17408(R) (EURAEC-584)
MADCAP, for calculating and plotting particle orbits in magnetic fields, 17: 17335(R) (ORNL-3392(p.56-65))
SAIL, for solution of neutron transport problems on IBM 709 or 7090, 17: 17093 (TID-18117)
COMPUTERS
converters for, design of analog-to-digital, 17: 16879
development of analog, for direct-reading spectrometers, 17: 15857(R) (ORNL-3397(p.57-70))
operations and uses at Univ. of Illinois, 17: 16508(R) (TID-18236)
syntax checker for Algol 60 for IBM-7090, 17: 16505 (ORNL-3399)
time delay unit design for analog, 17: 16503 (BLG-134)
use in activation analysis for remote lunar surface analysis, 17: 15888(R) (TID-18257)
use in bubble chamber data analysis, 17: 16419 (BNL-6871)
uses in experimental physics, 17: 16789 (TID-18145)
CONCRETES
cement content in finished, use of neutron source for measurement of, 17: 15901
CONFERENCES
Biological Effects of Ionizing Radiation at the Molecular Level, Brno, July 2–6, 1962, 17: 15762 (STI/PUB/60)
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Tenth Pacific Science Congress, Symposium on Isotopes Applications in the Soil and Crop Sciences, Honolulu, August 1961, 17: 15555
CONSTANTS AND CONVERSION FACTORS
determination of h/e, photoelectric method for, 17: 16809
tables for radiation intensity and absorption calculations, 17: 17080
CONVECTION (FORCED)
burnout in reactor fuel rod clusters, 17: 16238
CONVECTION (FREE)
from vertical plates, effects of magnetic field, 17: 16247
transients from flat vertical surfaces in air and water, 17: 16246
transients from vertical elements, 17: 16245
COPPER
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
conductivity and plastic behavior of whiskers of, under alpha irradiation, 17: 16762
determination in neptunium by ion exchange and spectrography, 17: 15896
determination of, in uranium fission products, 17: 15892
deuteron reactions (d,np) on, mechanisms for, 17: 17185
diffusion of hydrogen in, studies of, by d(d,p)T reaction, 17: 17289
effects on gas absorption by thorium-containing getter, 17: 16620(P)
fabrication of high-quality tubing of, 17: 16603 (ANL-FGF-409)
magnetoplasma resonance in, 17: 16841
neutron capture gamma spectra, 17: 17255
neutron elastic scattering and polarization by, at 2.8 Mev, 17: 17294
noble-gas-ion reactions on, secondary electrons from, 17: 16836
oxidation of, nucleation-germination phenomena in, 17: 16596(T,R) (EURAEC-559)
plastic deformation of, production of point defects in, 17: 16657 (TID-16506)
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
proton reactions at 120 and 660 Mev, yields from, 17: 17149
solvent properties of, for zirconium, 17: 16706
sorptive properties for iodine from air, 17: 16008
sputtering by argon ions at 25 kev, effects of angle of incidence on, 17: 16818
COPPER ALLOYS
analysis for thorium and zirconium using xylenol orange, 17: 15921
Al–Cu–Mn, neutron diffraction study of κ magnetic phase of, 17: 16702
Cu–Fe, oxidation, 17: 16667
Cu–Pu, phase diagram, 17: 16567
COPPER COMPLEXES
properties of, in hydrofluoric acid, polarographic studies, 17: 15961 (TID-18198)
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
COPPER CRYSTALS
argon ion reactions on, secondary electrons from, 17: 16837
COPPER FILMS
superconductivity, in contact with superconducting lead films, 17: 16830
COPPER ISOTOPES Cu-61
yields from deuteron reactions in zinc, 17: 17235
COPPER ISOTOPES Cu-63
electron inelastic scattering by, 17: 17233
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
proton elastic scattering at 7 to 12 Mev, cross sections for, 17: 16770(R) (ANL-6666)
reactions with oxygen-16, compound nucleus formation cross sections for, 17: 17118 (JINR-P-1162)
COPPER ISOTOPES Cu-64
yields from deuteron reactions in zinc, 17: 17235
COPPER ISOTOPES Cu-65

neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
proton elastic scattering at 7 to 12 Mev, cross sections for, 17: 16770(R) (ANL-6666)
COPPER ISOTOPES Cu-67
yields from deuteron reactions in zinc, 17: 17235
COPPER OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
COPPER PHOSPHATES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
COPPER SYSTEMS
$Cu(Hg)–Cu(H_2O)^{++}$, polarographic reduction of, in hydrofluoric acid, 17: 15961 (TID-18198)
CORROSION
bibliography on, 17: 16593 (VDIT-5a)
measurement of, microgravimetric method for, 17: 16585(R) (EURAEC-569)
radiation effects, 17: 16584(R) (EURAEC-550)
research in Soviet Union, visit for observation of, 17: 16592 (TID-17940)
research programs on, 17: 16596(T,R) (EURAEC-559)
theory of, solid state, 17: 16583(R) (EURAEC-545)
CORTICOSTERONES
radiation effects on synthesis of, in adrenal gland and blood plasma in rats, 17: 15808
CORTISONE
effects of, on course of *Trypanosoma lewisi* infection in rats, 17: 15573
effects of, on hair growth on irradiated mice, 17: 15822
COSMIC ALPHA PARTICLES
spectra of solar-flare, exponential rigidity, 17: 16927
COSMIC ELECTRONS
detection and measurement in space, 17: 16892
detection and measurement at 50 to 1000 kev, in space, 17: 16893
detection of soft, proportional counters for, 17: 16897
effects on solar cells in Van Allen belts, 17: 16884
intensities of geomagnetically trapped, 17: 16924
intensity in inner zone of Van Allen belt, 17: 16920
spectra of solar-flare, exponential rigidity, 17: 16927
COSMIC MESONS (μ)
intensity of high energy, near earth's surface, underground, and high in atmosphere, calculations of, 17: 16938
COSMIC MESONS (π)
attenuation mean-free-path calculations of, 17: 16938
COSMIC NEUTRINOS
reactions with artificial satellites, 17: 16863
COSMIC NEUTRONS
detection and measurement in space, 17: 16892
detection and measurement of slow, in atmosphere above Indian and Pacific Oceans, June 1960 to Dec. 1961, 17: 16933
energy and flux of, above the atmosphere, 17: 16922
intensity of, differences in onset times during Forbush decreases, 17: 16925
COSMIC NUCLEONS
spectra of solar-flare, exponential rigidity, 17: 16927
COSMIC PARTICLES
detection and measurement of charged, in space, 17: 16895
effects of heavy, on silicon-junction detectors in space, 17: 16885
energy distribution of multiply charged, below 1 Bev/nucleon, 17: 16929
energy spectrum of heavy primary, during solar maximum, 17: 16932
motion of trapped, in magnetosphere, 17: 16921
reactions in planetary and stellar atmospheres, 17: 16886
COSMIC PHOTONS
detection of soft, proportional counters for, 17: 16897
COSMIC PROTONS
detection and measurement in space, 17: 16892
detection and measurement at 10 to 100 Mev, in space, 17: 16893
effects on solar cells, in Van Allen belts, 17: 16884
flux of mirroring geomagnetically trapped, east-west asymmetry in, 17: 16918 (UCRL-10587)
intensities of geomagnetically trapped, 17: 16924
reactions on space vehicles, neutrons from, 17: 16876
shielding of manned space vehicles from, 17: 16877
source of ionospheric, charge exchange as dominant, 17: 16928
spectra of solar-flare, exponential rigidity, 17: 16927
COSMIC RADIATION
amplitude of 27-day variation and modified cutoff rigidity of, relation between equivalent, 17: 16923
book: *Cosmic Rays*, 17: 16936
detection and measurement in space, telemetry systems for, 17: 16879
effects on optical properties of satellite materials, 17: 15953 (NASA-TN-D-1523)
intensity during Forbush decrease, superimposed variations of, 17: 16926
intensity variations of primary, during Forbush decreases, 17: 16930
intensity variations of, energy spectrum of daily mean, 17: 16931
large ionization bursts and spectrum of, at mountain heights, 17: 16934
COSMIC-RAY SPECTRA
exponential rigidity of, 17: 16927
variations in, 17: 16930
COSMIC SHOWERS
spectra, 17: 16919
COSMOLOGY
antimatter-matter annihilation and, 17: 16911
neutrino absorption and emission in, 17: 16917
COULOMETERS
development for use in titrimetry, 17: 15851(R) (ORNL-3397(p.1-16))
indicator electrodes for, use of pyrolytic graphite for, 17: 15856(R) (ORNL-3397(p.54-6))
COULOMETRY
development for determining uranium in solutions, 17: 15852(R) (ORNL-3397(p.17-24))
COUNTING DEVICES
description of high resolving power, for low-energy gamma coincidence detection, 17: 16426 (ISS-62/26)
design and performance of transistorized decade, 17: 16390
design for counting of conductive balls moving into gas-tight chamber, 17: 16210(P)
design for tritium, 17: 15871 (AEET/HP/TM-10)
CRATERS
characteristics of nuclear explosion-induced, 17: 16330 (P-1951(RAND))
CRISTOBALITES
reactions with alkaline-earth sulfates, 17: 15986
CRITICAL ASSEMBLIES
development of JEEPNIK, 17: 17555(R) (TID-18108)
probability distribution of neutrons in, 17: 17091 (LADC-5383)
CRITICALITY STUDIES
neutron one-group theory in, 17: 17461
neutron production in homogeneous slabs and spheres in relation to critical size, 17: 17425 (RM-3256-PR)
CROSS SECTIONS
development of four-group, for SNAP core calculations, 17: 17422 (NAA-SR-Memo-7789)
CRUCIBLES
design and materials for, for plutonium production, 17: 16553
design of safe, for plutonium, 17: 16941 (RFP-63)
CRUSTACEA
calcium, cesium, strontium, and yttrium uptake by, 17: 15623
fission product metabolism, 17: 15609
rare earth content in, 17: 15604
CRYOGENICS
facilities at ORNL, 17: 17336(R) (ORNL-3392(p.66-85))
radiation effects on materials at low temperatures, 17: 16742(R) (NP-12628)
CRYSTAL STRUCTURE
angular momentum degeneracy of f-electron terms by cubic crystal fields, 17: 15940 (AFCRL-62-929)
Mössbauer effect for impurity nucleus in, 17: 16868
CRYSTALLOGRAPHY
computer program for calculating counter and crystal settings for collection of data, IBM 1620, 17: 15936 (AAEC/TM/179)
CRYSTALS
diffusion in, random-walk solutions for, 17: 16509
electrons in, analysis of conduction and localized, 17: 16795(T) (AEC-tr-5575)
gamma resonance absorption spectrum, effects of intracrystalline field,

17: 17272
interactions of electrons and photons at high energies in, review, 17: 17179
iron (III)-ion nuclear spin hamiltonians in, 17: 17210
lattice point defect configurations in, electron redistribution effects on, 17: 15956 (TID-16340)
mosaic-spread measurement, 17: 16811
structure of, computer program for selecting neutron or x ray diffraction investigation, 17: 16767 (AAEC/TM-180)
thermal conductivity in, effects of atomic admixtures on, 17: 15967(T) (SCL-T-468)

CUMENE
association constants of, with chloranil, deuterium isotope effects in, 17: 15991
radioinduced reactions with secondary aryl amine to form diaryl nitrogen oxide radicals, 17: 16064

CURIUM
properties and chemical separation methods of, 17: 15972

CURIUM ISOTOPES Cm-247
occurrence in minerals, 17: 16274

CURRENT INTEGRATORS
design, 17: 16404(P)

CUTTING TOOLS
design for decanning reactor fuel elements, 17: 16216(P)

CYANOGEN
radioinduced reactions with hydrocarbons, 17: 16042(R) (SRO-78)

CYCLOHEXANE
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)

CYCLOHEXANES
benzene-cyclohexane, hydrogen yield in radiolysis of, 17: 15768
radiolysis of mixtures of, hydrogen yields in, 17: 15768

CYCLOHEXANOL
dehydration of, radiation effects on catalytic activity of calcium chloride in, 17: 16040 (BMI-1620)

CYCLOHEXANONES
solvent properties for uranium, 17: 16151

CYCLOTRONS
description of 16-Mev, installed in Yugoslavia, 17: 17321
design for negative hydrogen ions, 17: 17319 (TID-18223)
nuclear reactions in, analysis of, 17: 17135

CYSTEINE
protective effects against x radiation in animal cells, 17: 15769
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668
radiosensitivity effects of, on mammals, 17: 15753
synergistic effects with aminoethylisothiuronium in prophylaxis and therapy of radiation injuries in monkeys, 17: 15633 (SAM-TDR-62-103)

CYSTINE
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668

CZECHOSLOVAKIA
plant for waste processing at Rey, design and operation of, 17: 17621
radioactivity in water, measurement methods of, 17: 15616(T) (JPRS-18391)

D

DAREX PROCESS
construction materials for, corrosion behavior of, 17: 17451

DATA TABULATIONS
angular momentum degeneracy of f-electron terms by cubic crystal fields, 17: 15940 (AFCRL-62-929)
catalog of solar radio bursts, 5-year, 17: 16912
correlation coefficients for 2-photon nuclear transitions, 17: 17286
earth motion from Gnome explosion, 17: 16265 (PNE-111F)
experimental de-excitation characters of 1^- state in the vibrational region around neutron number 90, 17: 17201
for radiation intensity and absorption calculations, 17: 17080
gamma emissions from radioisotopes, 17: 16353
properties of nuclides, 17: 17287
radioisotope performance in space propulsion systems, 17: 17611
triple angular correlation analysis in nuclear bombardment, coefficients for, 17: 17104 (CRP-615(Rev.))

DECONTAMINATING SOLUTIONS
composition for internal surfaces of in-pile loops, 17: 15868(P)
composition of noncorrosive, for cobalt alloys, 17: 15869(P)

DECONTAMINATION
of roofs, testing of recirculating washdown system, 17: 16309 (AD-297559)
of water, electrodialytic, 17: 15867(P)

DEHYDROGENASES
reactions with ribonucleotide derivatives of purine analogs, 17: 15542 (TID-18138)

DENSITOMETERS
design and development of, for measuring helium-graphite and nitrogen-graphite mixtures, 17: 16386(R) (TID-18162)
design and performance of gamma, 17: 16372 (TID-18124)

DENSITY
determination of sediment, by scattering of gamma rays, 17: 16372 (TID-18124)

DEUTERIDES
identification by photoneutron reactions, 17: 16332(R) (UCRL-7143)

DEUTERIUM
deuteron reactions(d,n), neutron polarization from, 17: 17125 (TID-18137)
electric charge of neutral molecular, upper limits for, 17: 17012
enrichment by ammonia synthesis, method for, 17: 16494(P)
exchange between hypophosphorous acid and water, kinetics, 17: 15988
exchange between p-xylene and water, geometric factor in catalytic, 17: 15863
hyperfine structure in atomic, state-dependent mass corrections to, 17: 16847
hyperons (Σ^-) capture by, impulse approximation for, 17: 17240
isotope effects in chloranil-methylbenzene complexes, 17: 15991
isotope effects in aldehyde oxidation by bromine, 17: 16037
mesons (K^-) reactions in, branching ratio ($\Lambda\pi^-p/\Sigma^0\pi^-p$) for, 17: 16981
oxidation rate in electrolysis, 17: 16493
performace in thermonuclear space-propulsion systems, 17: 16891
plasma of, energy loss rates in, 17: 17365
production of activated forms at very low temperature, 17: 15864
separation from hydrogen by reaction with alkali metal, 17: 16501(P)
spectra of, heterogeneous perturbations in absorption, 17: 15977
spectra of, isotopic effects on Λ doubling in absorption, 17: 15978
sticking factors for, on titanium film, 17: 17337(R) (ORNL-3392 (p.86-8))

DEUTERIUM HYDRIDES
spectra of, heterogeneous perturbations in absorption, 17: 15977
spectra of, isotopic effects on Λ doubling in absorption, 17: 15978

DEUTERONS
binding energy of ${}_{\Lambda}H^3$, 17: 17014
elastic scattering by titanium, iron, and nickel at 6.5 Mev polarization, 17: 17263
electron (+ and −) elastic scattering by, models for, 17: 17186
energy loss rates in plasma, 17: 17365
form factor of, determination from coherent meson (π^0) photoproduction, 17: 17020
formation at capture of stopped π^--mesons by light nuclei, 17: 17273
interactions with protons at 77 Mev, cross sections for, 17: 17009
interactions with deuterons at 20–70 Mev, cross sections and branching ratios for, 17: 17010
interactions with hyperons (Σ^-) at low energies, meson (π)-hyperon coupling constants for, 17: 17025
interactions with protons at 5 to 10 Mev, proton spectra from, 17: 17085
interactions with electrons, Coulomb dissociation in, 17: 17335(R) (ORNL-3392(p.56-65))
neutron elastic scattering by, 17: 17094 (TID-18277)
photodisintegration of, research on, 17: 17123(R) (TID-18127)
reactions (d,α) with lithium-7, 17: 17223
reactions (d,α) on nuclei, distributions from, 17: 17171
reactions (d,α) with beryllium-9, 17: 17245
reactions (d,He^3) with argon-40 and zinc-68, excitation functions for, 17: 17234
reactions (d,n) and (d,p) on nuclei, knock-out mechanism in, 17: 17168
reactions(d,n), neutron polarization from, 17: 17125 (TID-18137)
reactions (d,n) with lithium-7, neutron polarization in, 17: 17087

reactions (d,n) with tritium at 16 and 24 Mev, neutron polarization in, 17: 17083
reactions (d,n) with nitrogen-14 at 1.32 Mev, polarization of neutrons from, 17: 17127 (TID-18256)
reactions (d,np) and (d,2n) with hydrogen and tritium at 7 to 12 Mev, neutron spectra and angular distributions, 17: 17086
reactions (d,np) on copper and gold, mechanisms for, 17: 17185
reactions (d,p), study of low-lying levels by, 17: 17232
reactions of 20-Mev, activation cross section for, 17: 17216
reactions with argon-40, zinc-64, -66, and -67, excitation functions and thick-target yields for, 17: 17235
scattering by complex nuclei, optical potential in theory of, 17: 17122 (PUC-1962-78)
scattering of intermediate-energy, optical model with tensorial potentials for elastic, 17: 17005
splitting of, in field of deformed nuclei, 17: 17247
with arbitrarily oriented nuclei, polarization in direct, 17: 17244

DIELECTRIC BREAKDOWN
potential streamers in, 17: 16865

DIELECTRIC CONSTANTS
properties of generalized, 17: 17075

DIELECTRICS
radiation effects on liquid, 17: 16106
radiation effects, 17: 16763

DIET
effect of radiation-processed chicken, beef, and pineapple jam on wholesomeness, 17: 16368 (NP-12606)
effects of irradiated beef on wholesomeness of rat, 17: 16364(R) (NP-12602)
effects of irradiated eggs in dogs, 17: 16369 (NP-12607)
effects of radiation-processed beef on wholesomeness, 17: 16359(R) (NP-12596)
effects of radiation-processed beef on hemorrhagic syndrome in rats, 17: 16360(R) (NP-12597)
effects of radiation-processed beef on wholesomeness, 17: 16361(R) (NP-12598)
effects of radiation-processed carrots and pork on nutritional value, 17: 16362(R) (NP-12599)
effects of radiation processing of foods on wholesomeness, 17: 16365(R) (NP-12603)
effects of radiation-processed pork on wholesomeness, 17: 16366 (NP-12604)
effects of radiation processing of carrots in, on wholesomeness, 17: 16367 (NP-12605)
effects of radiation-processed potatoes on wholesomeness, 17: 16370 (NP-12608)
processed shrimp on thyroid activity, 17: 16363(R) (NP-12600)

DIFFERENTIATING CIRCUITS
switches for, development of tunnel diode, 17: 16382 (IDO-16823)

DIFFUSION
kinetics in radiation chemistry, free radicals reaction study of, 17: 16502 (ANL-6560)

DIFFUSION PUMPS
testing of, assembly for, 17: 17337(R) (ORNL-3392(p.86-8))

DIMETHYLAMINE
radiolysis products of, 17: 16043(R) (TID-18094)

DIODES
development of tunnel, for use in fast discriminating switches, 17: 16382 (IDO-16823)

DISKS
radiation diffraction around opaque, 17: 16945 (GAMD-1256)

DISTILLATION APPARATUS
development of continuous, for separation of hydrogen isotopes, 17: 16490 (DP-732)

DODECYLAMINES
tri-, solvent properties of, for hexavalent uranium, 17: 16155

DOGS
fecal and urinary excretion of tritium-labeled normorphine by, 17: 15601
iodine metabolism, tracer study, 17: 15588 (LADC-5209)
polonium effects on intestinal microflora in, 17: 15815(T)
radiation effects on micromotility of small intestine in, 17: 15683
radiation effects of plutonium-239 on blood serum albumen in, 17: 15741
radiation effects on, protective effects of bone marrow and spleen cells against lethal, 17: 15814
radiation effects on gastrointestinal tract, 17: 15838
radiation effects on, protective effects of bone marrow and spleen cells against lethal, 17: 15845
radiation sickness therapy in, bone marrow, 17: 15837
radiation sickness in, effects on cardiac sensitivity to adrenaline, 17: 15840
radiation sickness prophylaxis and therapy in, 17: 15841
radiotherapy of pulmonary carcinomas in, effects of direct, 17: 15830

DOORS
interlock system for, 17: 16199(P)

DRESDEN POWER REACTOR
operational experiences, 17: 17575

DROSOPHILA
radioinduced mutations, 17: 15681

DRUGS
protective effects of, against radiation injuries, action mechanisms for, 17: 15827
therapeutic effects of Albothyl instillation on bladder radiation injuries, 17: 15710

DRY BOXES
design of, for Plutonium Reclamation Facility, 17: 16141 (HW-68442)

DYES
radiolysis of methyl orange, in alcohol and water, 17: 16043(R) (TID-18094)
use of synthetic ultramarine for separation of francium-223 from other naturally occurring radioisotopes, 17: 16160

DYSPROSIUM
content of, in marine organisms, 17: 15604

DYSPROSIUM ALLOYS
Dy–Au, crystal structure, 17: 16658 (TID-18197)

DYSPROSIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001

DYSPROSIUM ISOTOPES Dy-160
energy level de-excitation characters for, experimental 1^-, 17: 17201
energy level lifetimes in, 2+ and 4+, 17: 17219

DYSPROSIUM ISOTOPES Dy-161
hyperfine structure of, 17: 17130 (UCRL-10630)
Mössbauer effect in, effect of pressure on, 17: 17130 (UCRL-10630)

DYSPROSIUM ISOTOPES Dy-162
energy level lifetimes in, 2+ and 4+, 17: 17219

DYSPROSIUM ISOTOPES Dy-165
gamma spectra, 17: 17165

DYSPROSIUM OXIDES
properties as reactor control material, tests of, 17: 16737 (GEAP-3927)

E

ECOLOGY
of loblolly pine, effects of ionizing radiation on, 17: 15802
radiation effects on wild bird populations, 17: 15635 (TID-17762)
radiation effects on natural plant community, 17: 15727

EGGS
radiation effects on lipids in yolks of chicken, 17: 15723
radiation processing, effects on wholesomeness, 17: 16369 (NP-12607)

EINSTEINIUM
properties and chemical separation methods of, 17: 15972

ELASTICITY
hydrodynamic equations for, computer programs for solution of, 17: 16660 (TID-18252)

ELASTOMERS
radiation effects, 17: 16100

ELECTRIC ARCS
barriers of, emission requirements for removal from direct energy converters, 17: 16769(R) (AI-7979)
development of low inductance, for ultraviolet light sources, 17: 16383 (JÜL-88-PP)
in molybdenum in toroidal hydrogen discharge, effects of impurity gases, 17: 16538

ELECTRIC CONDENSERS

operation of large low-inductance banks of, transient phenomena in, 17: 16782 (JUL-99-PP)
ELECTRIC CONDUCTIVITY
recovery of resistance to radioinduced, 17: 16651 (NAA-SR-Memo-1522)
ELECTRIC DISCHARGE
anode electron current in Penning, classical mobility mechanism for, 17: 16804
behavior of, in area of sub-normal low pressure glow, 17: 16802
energy conversion phenomenon, physical interpretation, 17: 17346
field distribution in Penning, Stark effect measurement of radial, 17: 16804
helical instability in positive-column, in magnetic field, 17: 17352
model for, in low-density neutral gas, 17: 17364
nitrogen recombination coefficients in, 17: 16888
spectra of pulse, recording with 10^{-8} sec time resolution, 17: 16393(T)
ELECTRIC FIELDS
hydrogen molecular ion dissociation in, 17: 16793(R) (TID-18265)
plasma instability in crossed magnetic and, 17: 17356
ELECTRIC GENERATORS
design of high-voltage d-c dynamo, 17: 16200(P)
design of nuclear-thermionic, 17: 17586(P)
performance of nuclear, for space propulsion, 17: 17611
ELECTRIC POWER
generation by gas discharge, physical interpretation, 17: 17346
ELECTRICAL ENGINEERING
analogies between conventional and nuclear power sources, 17: 17415 (HW-SA-2933)
ELECTRODES
current-potential relations at rotating-disc, in solutions, 17: 15964 (TID-18263)
design for cesium cells, 17: 16790 (TID-18216)
effects of contact with cadmium sulfide crystals on alpha-induced pulses in crystals, 17: 16092
ELECTROLYSIS
current-potential relationships at rotating-disc electrodes in, general equation for, 17: 15964 (TID-18263)
ELECTROLYTIC CELLS
design for preparation of alkali metal amides, 17: 15870(P)
design for uranium production, 17: 16134(P)
ELECTROMAGNETIC FIELDS
detection of Dirac point poles, CERN experiment on, 17: 16857
effects within a discontinuous conductor, 17: 16269
properties of nuclear, 17: 17306
ELECTROMAGNETIC PUMPS
characteristics of, for service in sodium (liquid) at 1000 to 20,000 gpm, 17: 16176 (NAA-SR-Memo-7955)
development of, for stepwise flux accumulation in superconducting magnet coils, 17: 16174 (LADC-5418)
ELECTROMAGNETIC WAVES
coupling to magnetohydrodynamic waves at plasma discontinuity, 17: 17363
dispersion function for, in plasma with Cauchy equilibrium distribution, 17: 17357
interactions with gravitational waves, theory, 17: 16858
propagation by glow discharges, at 500 to 4200 Mc, 17: 16889
propagation by plasma, 17: 17373
propagation through media, distortion effects on, 17: 16890
properties in plasma, nonlinear, 17: 17327 (ML-874)
resonance phenomena in the motion of a particle in, 17: 17052
scattering by plasma at equilibrium, total cross section for, 17: 17350
ELECTROMIGRATION SEPARATION
of alkali metal isotopes in fused salts, cell for countercurrent, 17: 16498(P)
of isotopes in fused salts, apparatus for, 17: 16496(P)
ELECTRON BEAMS
chemical effects on alanine and bovine serum albumins, 17: 15772
collimation of 20-Bev, 17: 17315 (ORNL-TM-524)
effects on free radical formation in proteins, 17: 15766
interactions with electromagnetic fields, "leaky wave" analysis of, 17: 17081
lithium ion ionization by, measuring cross section for, 17: 16792(R) (TID-18258)
modulation of, design of parametric amplifier for, 17: 16406(P)
oscillations and wave propagation in super-high frequency, 17: 17388
ELECTRON MICROSCOPY
use of, for localization of tritium-labeled DNA in bacteria, 17: 15596
ELECTRON PAIRS
annihilation of 600-Mev, 17: 16986
ELECTRON SCATTERING CROSS SECTIONS
determination for high energy electrons by initial and final polarizations, 17: 17053
velocity dependence of for energies $\lesssim 1$ ev, 17: 17269
ELECTRON SHOWERS
fluctuations of the number of particles in, determination by ionization losses, 17: 16935
ELECTRON SOURCES
design studies of monocapillary emitter for, in thermionic converter, 17: 16773(R) (EDR-3207)
ELECTRON TUBES
conference on photo-electronic image devices, 17: 16394
design of high-power klystron amplifier, 17: 16203(P)
getter fabrication for, thorium-containing, 17: 16620(P)
ELECTRONIC EQUIPMENT
performance of diode pump in counting nuclear particles and detecting power excursions in reactors, 17: 16420 (CEA-2185)
radiation effects of electrons on, on satellites, 17: 16875
ELECTRONS
biological effects of 30-Mev, 17: 15648
capture in annular accelerators, conditions for, 17: 17312 (IS-522)
Compton effect on bound, 17: 16780(R) (ISS-62/23)
diffusion across magnetic field in plasma, Brownian motion treatment of, 17: 17340 (TID-18115)
distribution function in anisotropic inhomogeneous plasma in modulated electric field, 17: 17347
distributions of geomagnetically trapped, produced by nuclear explosions, 17: 16875
effects of, on regenerating rat liver at 30 Mev, 17: 15677
effects of 30 Mev on carrier lifetime in silicon, 17: 16736(R) (GA-3872)
effects on matter, theory, 17: 16883
ejection and trapping of, in molecular solids, 17: 16751
electric charge difference from protons, upper limits for, 17: 17012
electric dipole moment of, upper limit for, 17: 17013
emission of secondary from noble-gas reactions on metals, 17: 16836
emission of secondary, from argon-ion reactions on copper, 17: 16837
energy loss in condensed media, 17: 15765
form factors determination by polarizations of, 17: 17053
formation of runaway, in plasma, 17: 17344
gases of, electromagnetic wave propagation by, 17: 17373
interactions at high energies in crystals, review, 17: 17179
interactions with antineutrinos and neutrinos, charge renormalization in elastic, 17: 16958 (UCRL-10336)
interactions with protons, infrared singularities in, 17: 16997
interactions with photons, low-frequency, high-intensity elastic, 17: 17008
interactions with mesons (μ^-) at 8 Bev, 17: 17017
interactions with deuterons, Coulomb dissociation in, 17: 17335(R) (ORNL-3392(p. 56-65))
interactions with electrons, pair correlation functions for, 17: 17350
interactions with ions, pair correlation functions for, 17: 17350
motion in uniform electric and magnetic fields, kinetic equations for, 17: 16964
penetration of, through aluminum, energy distribution in, 17: 16972
properties of gases of, dielectric formulation of, 17: 17075
scattering behavior on hydrogen atoms near 2s excitation level threshold, 17: 17270
scattering by fixed scatters, kinetic equations for, 17: 16964
scattering by hydrogen atoms, Born cross sections for inelastic, 17: 16848
scattering by nuclei at 0.183 to 1 Bev, models for elastic, 17: 17186
scattering by oxygen-18 at 150 Mev, 17: 17120 (LAL-1029)
scattering of, 17: 17233
scattering of conduction, in metals, 17: 16967
spatial distribution of, around an impurity in the nearly free electron approximation, 17: 16970

spectral line widths due to, calculation of, 17: 17324 (GAMD-927)
synthesis of organic compounds induced by high-energy, 17: 16072
transport theory for, electric conductivity tensor in, 17: 17064
ELECTROSTATIC PRECIPITATORS
design and operation of high-altitude, 17: 16320(R) (NYO-9675)
performance at simulated altitudes of 85,000 to 120,000 ft, 17: 16319(R) (NYO-9674)
ELEMENT ONE HUNDRED AND THREE
synthesis of, 17: 16085
ELEMENTARY PARTICLES
book: *Lectures on the Many-Body Problem*, 17: 17060
decay of ultrahigh-energy in condensed matter, 17: 17056
detection and production, solid angle computations for, 17: 16943 (AE-101)
equilibrium in weakly interacting systems of, 17: 17073
interaction symmetry of, irreducible internal variables and weak, 17: 16988
interactions of, Green functions in many-body, 17: 17069
interactions of, properties of vertex functions in strong, 17: 16954 (NP-12644)
interactions of, quantum field theory for, 17: 16960
interactions of, selection rules for non-leptonic, 17: 17000
interactions of, solution to Dirac equation for, 17: 16990
interactions of, theory of weak, 17: 16975
interactions of, vector-boson production during weak, 17: 17036
mass of, difference in small and zero, 17: 17022
models for, semi-empirical, 17: 16960
photoproduction of 300-Mev effective mass, from hydrogen, 17: 17109 (ISS-62/27)
photoproduction of 400-Mev effective mass, from hydrogen, 17: 17110 (ISS-62/28)
photoproduction of 500-Mev effective mass, from hydrogen, 17: 17111 (ISS-62/29)
photoproduction of 600, 900, and 1000-Mev effective mass, from hydrogen, 17: 17112 (ISS-62/30)
production in inelastic processes, behavior of cross section for, 17: 16949 (JINR-E-1156)
properties of positive, negative, and imaginary proper masses, 17: 16968
quantization of masses of, 17: 17044
reactions with nuclei, coefficients for triple angular correlations in, 17: 17104 (CRP-615(Rev.))
Regge trajectories and elementary poles for, 17: 17032
resonance phenomena in motion in a plane electromagnetic wave, 17: 17052
scattering amplitudes of, analyticity domain of partial, 17: 16956 (NYO-10239)
statistics for, theoretical possibility of unusual, 17: 16977
transmission of beam through linear magnetic system, computer program for, 17: 16944 (CERN-62-36)
weak interactions in the isospace $H(R_s)$, 17: 16976
ELEMENTS
origin, theory of neutron capture processes, 17: 17157
separation from hydrofluoric acid solutions by ion exchange, determination of optimum conditions for, 17: 16152
EMBRYOS
radiation effects on development, 17: 15541(R) (ORO-598)
radiation effects on developing nervous system, 17: 15638 (TID-18139)
radiation effects on nervous systems of rat, 17: 15745
radiation effects on, 17: 16339
EMISSIVITY
determination for refractory materials, 17: 16632(R) (AD-274654)
measurement and shaping of, equipment design for, 17: 17328 (NP-12635)
measurement of, for selected materials, 17: 16787(R) (PWA-2163)
satellite environment effects on, of materials, 17: 15953 (NASA-TN-D-1523)
ENZYMES
radiation effects on, in regenerating rat liver, 17: 15785
radioinduced inactivation of, physical mechanisms in, 17: 15780
radioinduced inactivation of, mechanism of, 17: 15783
radiosensitivity effects of, on mammals, 17: 15753
EPHEDRINE
radiation effects on toxocity of, on mice, 17: 15678
EPITHELIUM
radiation effects on intestinal, 17: 15632(R) (ORO-584)
ERBIUM
content of, in marine organisms, 17: 15604
ERBIUM ALLOYS
Er–Au, crystal structure, 17: 16658 (TID-18197)
ERBIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
ERBIUM ISOTOPES Er-165
decay of, electron and gamma ray spectra from electron capture, 17: 17136
ERBIUM ISOTOPES Er-166
energy level de-excitation characters for, experimental 1^-, 17: 17201
energy level lifetimes in, 2+ and 4+, 17: 17219
ERBIUM ISOTOPES Er-168
deuteron reaction (d,p), study of low-lying levels by, 17: 17232
energy level lifetimes in, 2+ and 4+, 17: 17219
ERYTHROCYTES
radiation effects on membrane of, 17: 15787
radiosensitivity of, effects of monoiodoacetic acid on, 17: 15786
ERYTHROPOIESIS
radiation effects on, in rats, 17: 15742
reactivation of, in rats by cobalt after irradiation, 17: 15810
ERYTHROPOIETIN
effects of, on stem cells combined with radiation in mouse *in vivo*, 17: 15725
ESCHERICHIA COLI
radiation effects on, type-analysis of dose-effect and dose-survival of, 17: 15703
ESTERS
radiation effects on aliphatic polymeric, with polyunsaturated polyester modifiers, 17: 16115(P)
radiation effects on aliphatic polymeric, with polyunsaturated polyalkenyl aryl modifiers, 17: 16118(P)
radiation effects on aliphatic polymeric, with polyunsaturated polyether modifiers, 17: 16119(P)
ETHANETHIOL, 2-AMINO-
effects on blood changes induced by cooling and x irradiation, 17: 15796
effects on metabolism in irradiated lymph cells, 17: 15833
protective effects of, against radiation, 17: 15846
radiosensitivity effects of, hypothesis for, 17: 15795
radiosensitivity effects, 17: 15841
ETHANOL
photochemical reactions with iodine, 17: 16038
ETHYL ETHER
photochemical reactions with iodine, 17: 16038
ETHYLAMINE, 2,2'-DITHIOBIS-
protective effects of, against radiation, 17: 15846
ETHYLENE
radioinduced graft polymerization to textiles, 17: 16041(R) (NCSC-2477-10)
reactions with recoil carbon, effects of phase on, 17: 16078
ETHYLENE, CHLORO-
radioinduced graft polymerization to textiles, 17: 16041(R) (NCSC-2477-10)
ETHYLENE, CHLORO- POLYMERS
radiation effects on, in methanol, 17: 16082
radiation effects on induced dielectric strength and electromotive force in, 17: 16761
ETHYLENE, FLUORO-
radiopolymerization, 17: 16113(P)
ETHYLENE OXIDE
reactions with recoil carbon, effects of phase on, 17: 16078
ETHYLENE POLYMERS
gamma buildup factors for, Monte-Carlo analysis of, 17: 17466
performance as vials for low-level-beta scintillation counting, 17: 16458
EUGLENA
ultraviolet induced apochlorosis and photoreactivation in two strains, 17: 15640 (TID-18203)
EUROPE

research center for radiation biology, status, 1961, 17: 15535(T) (UCRL-Trans-904)
EUROPIUM
content of, in marine organisms, 17: 15604
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
EUROPIUM BORATES
properties as reactor control material, tests of, 17: 16737 (GEAP-3927)
EUROPIUM BORIDES
electric conductivity of hexa-, 17: 16726
EUROPIUM CARBONATES
preparation by precipitation, 17: 15951 (LADC-5579)
preparation, properties, and structure, 17: 15950 (LADC-5566)
thermal decomposition of, compound formations in, 17: 15951 (LADC-5579)
EUROPIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
EUROPIUM FLUORIDES
preparation, properties, and structure, 17: 15950 (LADC-5566)
EUROPIUM ISOTOPES Eu-152
gamma spectra, 17: 17165
EUROPIUM OXIDES
crystal structure, 17: 17446
radiation and temperature effects on mechanical and physical properties of, 17: 16760
Eu_2O_3–SS, corrosion by water, 17: 17446
EUROPIUM SULFATES
preparation, properties, and structure, 17: 15950 (LADC-5566)
EUROPIUM TUNGSTATES
crystal structure of, x-ray diffraction studies of, 17: 16663 (UCRL-10344)
EUXENITES
content and crystal structure, 17: 15982
EXOSPHERE
hydromagnetic frequency cutoff in, 17: 16296
EXPERIMENTAL BOILING WATER REACTOR
development of, lectures on, 17: 17403 (ANL-6640)
EXPERIMENTAL BREEDER REACTOR-II
fuel alloy development for, 17: 16571
fuel assembly fabrication for Core I, 17: 16602 (ANL-6276)
EXPERIMENTAL GAS COOLED REACTOR
access tubes and thermal columns in, design and analysis of, 17: 17569 (TID-18249)
burst slug detection system of, functional test for, 17: 17530 (ACNP-62509)
burst slug detection equipment for, shielding analysis for, 17: 17562 (TID-18241)
burst slug detection system for, design requirements of, 17: 17563 (TID-18242)
charge machine, testing of blister drive seals for, 17: 17427 (TID-18234)
control rod alignment and freedom in channels of, 17: 17570 (TID-18250)
coolant flow distribution to core components in, 17: 17568 (TID-18248)
core gas seals for, design of, 17: 17551 (TID-18099)
core structure, design of bottom plate for, 17: 17565 (TID-18244)
core supports, gamma and neutron heating estimates for, 17: 17547 (TID-18095)
design of top grid structure and associated components, 17: 17558 (TID-18237)
design requirements for core structure, 17: 17560 (TID-18239)
fast neutron leakage from, analysis of, 17: 17564 (TID-18243)
fuel charge machine for, seal test for blister drives of, 17: 16180 (TID-18233)
fuel element assemblies, design requirements for dummy, 17: 17567 (TID-18247)
graphite core structure stress analysis, 17: 17571 (TID-18251)
instrumented fuel column for, design, 17: 17553 (TID-18102)
loading and unloading of, cooling requirements for, 17: 17552 (TID-18101)
moderator and reflector temperature distributions, effects of coolant flow on, 17: 17550 (TID-18098)
moderator peripheral restraints for, design and analysis of, 17: 17557 (TID-18235)
moderator temperature distributions, coolant flow requirements for, 17: 17559 (TID-18238)
neutron flux distributions in, calculation of, 17: 17566 (TID-18245)
neutron leakage from, calculation of fast, 17: 17554 (TID-18106)
neutron streaming from core of, current estimates, 17: 17548 (TID-18096)
service machine, analysis of shielding for, 17: 17549 (TID-18097)
temperature monitoring system for, design of pneumatic, 17: 17561 (TID-18240)
EXPERIMENTAL ORGANIC COOLED REACTOR
development and operation, 17: 17416(R) (IDO-16830)
EXPLOSIVES
radiation effects, 17: 16108
EXPONENTIAL PILES
research with, 17: 17419(R) (MITNE-26)
EXTRACTION APPARATUS
mass transfer in stirred vessel extractor, hydrodynamic model, 17: 16241
EYES
corneal transplantation, isotopic labeling of donor cells, 17: 15586
protection of, in telecobalt therapy, 17: 15756
radiation effects on mitosis of crystalline lens in rabbit, 17: 15818(T)

F

FALLOUT
carbon-14 content in thymol from essential oils, 17: 15618
characteristics of nuclear explosion-induced, 17: 16330 (P-1951(RAND))
contamination of human organs by, 17: 16346
content in milk and vegetables in Winnipeg, Canada, health implications of, 17: 15619
content in milk in Norway during 1961, 17: 15614 (A/AC.82/G/L.810)
deposition in and removal from drainage area of Vistula River, 17: 15617
deposition in Winnipeg, Canada, health implications in, 17: 15619
distribution in soil from weapons tests, 17: 16288
effects on wild bird populations, 17: 15635 (TID-17762)
fractionation in highly-radioactive particles, 17: 16344
gamma intensity in complex from, method for computing, 17: 17393 (NP-12611)
monitoring in animals and humans, Leningrad, 1958 to 1960, 17: 16304
monitoring of, in Federal Republic of Germany, April to June 1962, 17: 15625
monitoring of, in Federal Republic of Germany, January to March 1962, 17: 15624
monitoring, research program of AEC, 17: 16331 (TID-12616(Rev.1))
radioactive precipitation detection at weather stations, probability, 17: 16267
radioactivity fixation by ants, 17: 15620
removal from roof-washdown by filtering and settling, 17: 16309 (AD-297559)
FAST NEUTRONS
capture gamma spectra comparison, 17: 17255
diffusion in hydrogen at 2, 4, 6, 8, 10, 12, and 14 Mev, 17: 17460
distributions of, by leakage, from Experimental Gas Cooled Reactor, 17: 17554 (TID-18106)
dose estimates of, in SL-1 accident, 17: 16315 (LADC-5359)
effects on wheat, seed and seedling exposure, 17: 15748
elastic scattering on tungsten, lead, bismuth, thorium, and uranium, angular distribution of, 17: 17097
leakage from EGCR, analysis of, 17: 17564 (TID-18243)
monitoring of, design of transistorized, portable rate meter for, 17: 16468
scattering by uranium, cross sections for elastic, 17: 17159
spectra of, method for measuring, 17: 16438
uses in activation analysis of lunar surfaces, 17: 16894
FAST REACTORS
design of mixed-oxide plutonium-fueled, 17: 16576
design of mixed-oxide sodium cooled, 17: 17409(R) (GEAP-3811)
design of paste fuel, 17: 16575
development at ANL, review, 17: 16555
reactivity of sodium cooled, 17: 17409(R) (GEAP-3811)
use as irradiated fuel enrichment facilities for thermal reactor fuels, 17: 17413(R) (HW-74549)
FATIGUE
stress state effects on high-temperature low-cycle, 17: 16654 (ORNL-

3398)
FATTY ACIDS
synthesis in tritiated media, reaction mechanisms, 17: 15595
FECES
analysis of, for iodine-131, method for direct, 17: 15904
analysis of, for radioactivity, method for, 17: 15894
excretion of tritium-labeled normorphine in, of dogs and monkeys, 17: 15601
FERMI FAST BREEDER REACTOR
coolant and fuel pin behavior under conditions of boiling and meltdown, model studies, 17: 17556 (TID-18229)
development, 17: 17424(R) (PRDC-TR-62)
FERMIONS
book: *Lectures on the Many-Body Problem*, 17: 17060
ground state theory of imperfect gases of, 17: 17061
inertia moments for large superfluid systems of, 17: 17068
interactions of four, theory for weak, 17: 16975
perturbation formalism for many-body problem of, 17: 17063
perturbation formalism for many-body system of, 17: 17071
perturbation formalism for many-body system of, 17: 17072
properties of many-particle systems of, zero-temperature, 17: 17031
quantum statistical mechanics of negative-energy, 17: 16998
scattering by nuclei, models for elastic, 17: 17186
theory of, functional integrals in formulation of, 17: 17066
theory of gases of, canonical transformation for, 17: 17062
theory of normal systems of, 17: 17078
theory of systems of, properties of linked-cluster expansion in, 17: 17074
wave function for gases of, structure of, 17: 17077
FERMIUM
properties and chemical separation methods of, 17: 15972
FERROMAGNETIC MATERIALS
demagnetizing, design of device for, 17: 16402(P)
nuclear magnetic resonance, 17: 16772 (CEA-2213)
FERTILIZERS
effect of mineral, on plant uptake of strontium isotopes from soil, 17: 15613
isotopic exchange reactions of mineral solutions with soil, 17: 15581
FETUSES
immunologically reactive cells, development, 17: 15644 (USNRDL-TR-605)
radiation effects on developing nervous system, 17: 15638 (TID-18139)
FIELD THEORY
analyticity and boundedness of three-point function in, 17: 16824
baryon eightfold-way assignments in, 17: 17043
boson production during weak interactions, copious, 17: 17036
commutation relations and conservation laws for, 17: 16851
elementary particle interactions in, 17: 16960
elementary-particle weak interactions in, 17: 16975
elementary-particle weak interactions in, 17: 16976
elementary particle statistics in, possibility of unusual, 17: 16977
elementary-particle-mass quantization in, 17: 17044
functional integrals of, in statistical mechanics, 17: 17066
gravitation waves in, theory of plane, 17: 16858
indefinite metric of covariant, and Lorentz covariant Lee model, 17: 16856
interactions in nuclear matter in, velocity-dependent, 17: 17164
many-body problem in, 17: 17063
meson (π) resonances in, 17: 17037
meson relations to Regge poles in, vector, 17: 17045
models for small-angle particle scattering in, 17: 16999
nucleons as Regge poles in, 17: 17038
quantization of fields in, 17: 16826
regularization of, using counterfields, 17: 16825
selection rules for non-leptonic interactions in, 17: 17000
singularities in electron-proton scattering amplitudes in, 17: 16997
singularities of s-matrix after a canonical transformation, 17: 16978
theorem on local commutativity in quantum, 17: 16828
thermal properties of metals in, 17: 16806
variation method in, 17: 16853
FILMS
ablation of grease, 17: 16224 (GAMD-2237)
behavior of thin viscous, mechanical and thermal effects on, 17: 16225 (GAMD-2257)
deposition from organic coolants on heated rods, PCFT determination of, 17: 17423 (NAA-SR-Memo-8088)
radiation effects on organic, 17: 16105
FILTERS
design of equipment for purification of liquid sodium coolant, 17: 17436
development, 17: 16332(R) (UCRL-7143)
FINNED TUBES
design for fuel elements, 17: 17493(P)
FISH
rare earth content in salt water, 17: 15604
FISSION
characteristics for low excitation energies, review, 17: 17283
distribution in pin-type fuel elements, 17: 17128 (UCRL-6695)
lifetime of compound nuclei in, 17: 17299
models for heavy-ion, on bismuth-209 and gold-197, 17: 17225
FISSION CHAMBERS
design, 17: 17426(R) (TID-17385)
design and performance of neutron-phoswich, for space uses, 17: 16892
development for high-temperature uses, 17: 17411(R) (GEMP-177C)
FISSION PRODUCTS
adsorption and metabolism in plankton, 17: 15609
control and properties of accident-release, 17: 16327(R) (ORNL-3401 (p.43-55))
determination in solutions of irradiated fuels, by gamma spectrography, 17: 15874 (CEA-2226)
diffusion and release of, on out-of-pile melting of reactor fuels, 17: 16323(R) (ORNL-3401(p.5-27))
diffusion from fuel elements in in-pile melting or burning, 17: 16324(R) (ORNL-3401(p.27-35))
diffusion from reactor fuels on in-pile melting under transient reactor conditions, 17: 16325(R) (ORNL-3401(p.35-9))
diffusion of gaseous, from uranium dioxide pellets, 17: 16645(R) (EURAEC-568)
diffusion of, in graphite, mechanisms for, 17: 16744(R) (TID-18112)
distributions from low-excitation fissions, review, 17: 17283
metabolism in swine and cattle, 17: 15541(R) (ORO-598)
release from graphite, 17: 16690
release of, in reactor containment vessel, Nuclear Safty Pilot Plant for studying, 17: 16328(R) (ORNL-3401(p.57-60))
removal from homogeneous reactors, system for, 17: 17526(P)
separation from hydrofluoric acid solutions by ion exchange, determination of optimum conditions for, 17: 16152
separation from plutonium and uranium by gradient multistage extraction using TBP, 17: 16158
separation from Purex wastes, 17: 17453
separation of cesium from concentrates of, by ion exchange, 17: 16139 (AERE-R-4245)
sorption by zeolites, waste packaging studies of, 17: 17615(R) (HW-76262)
survey of radioactive and stable, 17: 17426(R) (TID-17385)
FISSION RECOILS
kinetic energies and ranges of, from 150-Mev proton fission of uranium-238, 17: 16051(R) (TID-18261(p.27-43))
use in direct conversion of energy, 17: 16189
yields of proton, from indium and silver, 17: 16053(R) (TID-18261 (p.49-60))
FISSIONABLE MATERIAL
preparation of standard, for use in absolute fission yield determinations, 17: 17426(R) (TID-17385)
FISSIUM
properties as reactor fuel, 17: 16571
FLANGES
design for waveguide connections, 17: 17317(R) (SLAC-8)
FLOWMETERS
design for monitoring coolant flow during reactor refueling operations, 17: 16254(P)
design of, using radioisotopes to determine flowrate and turbulence, 17: 16405(P)
performance of gas, at high-altitudes, 17: 16320(R) (NYO-9675)
properties, 17: 16253
FLUID FLOW

cavitation performance variations in stationary and rotating components, 17: 16243
conference on measurement of cloud-conduit, 17: 16253
fuel rod vibration in parallel, 17: 17537 (GEAP-4059)
of air-water systems through vent tube, analytical models for, 17: 16233(R) (TID-18141)
of steam-water mixtures in annuli, two-phase critical, 17: 16239

FLUID FLOW (LAMINAR)
friction factors prediction theory for, in constant-diameter tubing, 17: 16232 (TID-16555)

FLUID FLOW (TURBULENT)
friction factors prediction theory for, in constant-diameter tubing, 17: 16232 (TID-16555)
heat transfer and skin friction for boundary-layer, longitudinal to circular cylinder, 17: 16242
heat transfer in, 17: 16236(T) (AERE-Trans-911(Pts.1&2))
magnetohydrodynamic, nonisentropic perturbations of, 17: 16510
skin friction in, in channels, 17: 16229 (NP-12631)

FLUID FUEL REACTORS
design of fluidized-bed, organic moderated, 17: 17428 (WCAP-1635)
design of paste fuel, 17: 16575
development of plutonium-containing, 17: 16574
fuel sphere counting device, 17: 16210(P)

FLUIDIZATION
heat transfer in fluidized beds, 17: 16249

FLUIDS
hydromagnetic motion generated by oscillating solid boundaries in, 17: 17397

FLUORESCENCE
Compton effect on yields of, 17: 16780(R) (ISS-62/23)

FLUORIDE FILMS
refractive indices of, immersion spectrophotometric determination of, 17: 15949 (LADC-5374)

FLUORIDE VOLATILITY PROCESSES
corrosive effects on construction materials, 17: 15532(R) (BMI-1607 (Del.))
development, 17: 17404(R) (BNL-164)
development for uranium-zirconium fuels, review, 17: 17452

FLUORIDES
free energies and heats of formation of reactive-metal, 17: 16568
solvent properties for thorium, 17: 16161
solvent properties for thorium, 17: 16162
solvent properties for thorium, 17: 16163

FLUORINE
reactions with nickel, mechanism of, 17: 15998

FLUORINE IONS
preparation of beam of, by bombardment of boron fluoride with 30-kev krypton ions, 17: 17253

FLUORINE ISOTOPES F-17
energy levels of, proton-scattering studies, 17: 17300

FLUORINE ISOTOPES F-18
formation cross sections in proton reactions, 17: 17149
residual pair forces in nuclei of, 17: 17275

FLUORINE ISOTOPES F-19
proton reactions (p,α), backward peaks in angular distributions from, 17: 17188

FLUOROAROMATIC COMPOUNDS
radioinduced production, 17: 16121(P)

FOOD
barium, calcium, and strontium contents in, estimation of, for components of Canadian diet, 17: 15587 (CRER-1068)
contamination from fallout, health implications of, 17: 15619
effects of radiation processing of pork on wholesomeness, 17: 16366 (NP-12604)
effects of radiation processing of beef on wholesomeness, 17: 16360(R) (NP-12597)
radiation processing of fruit and fish, 17: 15558
radiation processing of meats, effects on wholesomeness, 17: 15631 (NP-12601)
radiation processing of beef, effects on wholesomeness, 17: 16359(R) (NP-12596)
radiation-processing of beef, effect on wholesomeness, 17: 16361(R) (NP-12598)
radiation processing of carrots, effects on nutritional value, 17: 16362(R) (NP-12599)
radiation processing of pork, effects on nutritional value, 17: 16362(R) (NP-12599)
radiation processing of shrimp, effects on wholesomeness, 17: 16363(R) (NP-12600)
radiation processing of beef, effects on wholesomeness, 17: 16364(R) (NP-12602)
radiation processing of beef and shrimp, effect on wholesomeness, 17: 16365(R) (NP-12603)
radiation processing of carrots, effects on wholesomeness, 17: 16367 (NP-12605)
radiation processing of chicken, beef, and pineapple jam, effect on wholesomeness, 17: 16368 (NP-12606)
radiation processing of eggs, effects on wholesomeness, 17: 16369 (NP-12607)
radiation processing of potatoes, effect on wholesomeness, 17: 16370 (NP-12608)
radiation processing of oranges, effects on wholesomeness, 17: 16371 (NP-12609)
radiation processing, 17: 16373
radiation processing of fruits, 17: 16374
radiation processing of fruits and vegetables, 17: 16375
radioactivity of, measurements in Federal Republic of Germany, January to March 1962, 17: 15624
radioactivity of, measurements in Federal Republic of Germany, April to June 1962, 17: 15625
radiosterilization of broccoli, strawberries, and sweet corn, effects on flavor and storage time, 17: 15675

FORESTS
radiation effects on growth and reproduction in pine-oak, 17: 15730

FRANCIUM ISOTOPES Fr-223
separation from other naturally occurring radioisotopes by ion exchange using ammonium molybdatophosphate, 17: 16159
separation from other naturally occurring radioisotopes by ion-sieve effect on ultramarine, 17: 16160

FREE RADICALS
electron spin resonance studies in biology, 17: 15547
radiation effects on content of, in rat liver lipids, 17: 15672
radioinduced in amino acids, nucleic acids, and proteins, 17: 15767
radioinduced in DNA, 17: 15773
radioinduced in isomeric poly(butyl methacrylates), mechanism of, 17: 16070
radioinduced in polyamides, electron spin resonance spectra of, 17: 16069
radioinduced in polymethyl methacrylate, electron spin resonance studies of decay, 17: 16060
radioinduced in proteins, kinetics of, 17: 15766
radioinduced in seeds, content and decay of, 17: 15763

FRETTING-CORROSION INHIBITORS
performance of Zircaloy-2 as, in cladding for thermocouples, 17: 16588 (HW-75626)

FRICTION
bibliography on high-temperature, 17: 16169 (AD-282462)
wear in, use of radioisotopes for measurement of, 17: 16377

FROGS
radiation effects on ovulation in, 17: 15743

FUNGI
radiation effects on mutations in *Neurospora crassa*, visible and x-ray, 17: 15652
radioinduced mutations of *Aspergillus nidulans*, 17: 15679

FURAN
radiation stability, 17: 16063

FURNACES
design description of electron-bombardment, 17: 16191

FUSED SALTS
analysis by electrochemical methods, 17: 15853(R) (ORNL-3397(p.24-6))
analysis of, sample stability improvement in spectrophotometric, 17: 15854(R) (ORNL-3397(p.26-38))

G

GADOLINIUM
content of, in marine organisms, 17: 15604
thermal capacity at 0.4 to 4°K, 17: 16015
GADOLINIUM ALLOYS
Bi_3Gd_4, ferromagnetism of, 17: 16670
Gd–Au, crystal structure, 17: 16658 (TID-18197)
Gd–Ni, effect of annealing on coercive force of deformed, 17: 16716
GADOLINIUM CARBONATES
preparation by precipitation, 17: 15951 (LADC-5579)
thermal decomposition of, compound formations in, 17: 15951 (LADC-5579)
GADOLINIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
GADOLINIUM CRYSTALS
magnetostriction and thermal expansion, 17: 16703
GADOLINIUM IONS
paramagnetic resonance spectrum of in lanthanum aluminate, 17: 16016
paramagnetic resonance in palladium in presence of rare earth impurities, 17: 16819
GADOLINIUM ISOTOPES Gd-152
energy level de-excitation characters for, experimental 1^-, 17: 17201
GADOLINIUM ISOTOPES Gd-156
energy level de-excitation characters for, experimental 1^-, 17: 17201
GADOLINIUM OXIDES
radiation and temperature effects on mechanical and physical properties of, 17: 16760
GAGES
design of radiation, for determination of composition and physical properties, 17: 16487(P)
GALLIUM
separation of, from cobalt, manganese, nickel, and zinc, using cinnamic acid, 17: 15924
GALLIUM ALLOYS
Ga–Pu, preparation, 17: 16568
GALLIUM ARSENIDES
arsenic and gallium nuclear spin levels in, 17: 17209
GALLIUM CHLORIDES
chlorine-36 exchange from, to nitrosyl and phosphoryl chlorides, 17: 15996
GALLIUM ISOTOPES Ga-66
yields from deuteron reactions in zinc, 17: 17235
GALLIUM ISOTOPES Ga-67
yields from deuteron reactions in zinc, 17: 17235
GALLIUM ISOTOPES Ga-68
decay of, gamma energies from, 17: 17142
GALLIUM ISOTOPES Ga-69
nuclear spin levels in, in gallium arsenide crystals, 17: 17209
GALLIUM ISOTOPES Ga-71
nuclear spin levels in, in gallium arsenide crystals, 17: 17209
GALLIUM OXIDES
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
GAMMA RADIATION
absorption of, effects of pressure on resonance, 17: 17130 (UCRL-10630)
angular distribution from uranium-235 fission, 17: 17203
atmospheric ionization by, from high-altitude explosions, 17: 16292
attenuation by polyethylene, Monte-Carlo calculation of, 17: 17466
biochemical effects on blood-serum and hepatic proteins, 17: 15770
chemical effects on organic liquid mixtures, 17: 15768
chemical effects on nucleic acids and nucleoproteins, 17: 15771
chemical effects on DNA, 17: 15773
chemical effects on 3-indoleacetic acid, 17: 15776
chemical effects on β-lactoglobulin, oxygen effect in, 17: 15778
chemical effects on hydrogen peroxide and water, 17: 16058(T) (AEC-tr-5687)
chemical effects on plutonium hexafluoride, 17: 16045 (TID-18184)
detection and measurement from nuclei with A = 152 to 197, 17: 17165
detection of low-energy, coincidences of, high resolving power apparatus for, 17: 16426 (ISS-62/26)
effects of chronic, low-level exposure on growth and reproduction in pine-oak forest, 17: 15730
effects of, on desoxyribonucleoprotein in spleen in mice, 17: 15706
effects of, on dogs, protective effects of bone marrow and spleen cells against lethal, 17: 15814
effects of, on hemagglutinin and infectivity of influenza viruses, protective effects of chemicals against, 17: 15668
effects of, on lipids in chicken egg yolks, 17: 15723
effects of, on nervous system of white rats, chronic whole-body, 17: 15744
effects on bacteriophages, mechanism of, 17: 15791
effects on cell growth in leaves, 17: 15651
effects on diploid and haploid yeast cells, 17: 15739
effects on free-radical content in seeds, 17: 15763
effects on growth and morphology of *Pinus monophylla*, acute exposure, 17: 15733
effects on growth and development of oak trees, chronic, low-level exposure, 17: 15734
effects on matter, theory, 17: 16883
effects on metabolism in lymph cells, 17: 15833
effects on plant community, 17: 15727
effects on rabbit tropomyosin, 17: 16379
effects on thymocytes, morphological, 17: 15667
effects on tissue culture oxidation reactions, 17: 15738
emission by aligned nuclei, correlation coefficients for double, 17: 17286
emission by even nuclei, E2/M1 ratios in, 17: 17172
emission by holmium-166, lutetium-176, and thulium-170, 17: 17181
equality of velocity in a transverse magnetic field, 17: 16974
genetic effects in maize, 17: 15626 (BNL-6027)
genetic effects in mice, chronic low-dose exposure, 17: 15686
genetic effects on Aspergillus, 17: 15679
intensity of, in presence of general shielding and source configurations, 17: 17393 (NP-12611)
lethal dosage determinations for bacterial spores, 17: 15718
reactions (γ,π^p) on nuclear Coulomb fields, 17: 17184
reactions (γ,n) on yttrium-89 and zirconium-90, 17: 17158
reactions on nuclei, mesons (π) from, 17: 17163
reactions on nuclei, giant resonance effects in, 17: 17284
reactions on unfilled-shell nuclei, giant resonance in, 17: 17160
reactions with gases, ion pair production in, 17: 16086
reactions with hydrogen at 187 Mev, angular distribution of mesons (π) from, 17: 16985
relations of in-core distribution, with reactor power output, 17: 17410 (GEAP-3914)
resonance absorption spectra, effects of intracrystalline fields, 17: 17272
scattering by lead screens, radiographic intensification factors for, 17: 17394
uses in analysis of lunar surfaces, 17: 16894
GAMMA SHIELDING
buildup factors for complex, method for calculating, 17: 17393 (NP-12611)
design of optimum shadow, for isotropic point source, 17: 17392 (GAMD-2271)
GAMMA SOURCES
activity measurements of, principles of coincidence method for, 17: 16439
design of 2000-curie, chemical determination of isodose curves in, 17: 15578
dosimetry of cobalt-60 and cesium-137 for field plant irradiation, 17: 15732
shielding for cobalt-60 therapy, use of aluminum and tungsten, 17: 15663
GAMMA SPECTRA
analysis by computers, 17: 15858(R) (ORNL-3397(p.71-112))
from radiative capture of thermal and fast neutrons, comparison of, 17: 17255
measurement, 17: 16438
measurement of neutron-capture, method for, 17: 17207
reduction of reactor pulse-height data, mathematical method for, 17: 16959
GAMMA SPECTROMETERS

description of bent-crystal, for DR-3 reactor, 17: 16447
description of bent-crystal, for DR-3 reactor, 17: 16448
performance, 17: 16353
GAMMA SPECTROSCOPY
use in analysis of irradiated fuel solutions for fission products, 17: 15874 (CEA-2226)
uses in reactor-associated analyses, 17: 15858(R) (ORNL-3397 (p.71-112))
GAS ANALYZERS
design of oscillating-ion mass-spectrometer, for use in vacuum, 17: 15935(P)
GAS CENTRIFUGES
design of ultra-, for isotope separation, 17: 16495(P)
GAS COOLED REACTORS
coolant collection and distribution vessels for, 17: 17501(P)
coolant purification circuit, 17: 17508(P)
core restraint garter design, 17: 17496(P)
design studies for mobile, 17: 17541(R) (IDO-28602)
design with heat exchanger, 17: 17587(P)
loading, design of servicing mechanism for, 17: 17490(P)
loading for uniform output, 17: 17475(P)
safety device for preventing gas backflow into storage tank, 17: 17511(P)
standpipe plug design, 17: 16211(P)
GAS MASKS
development for protection against radioactive particulates, 17: 16314 (LADC-5343)
evaluation for protection against uranium compounds and highly toxic materials, 17: 16316 (LADC-5410)
GASES
acceleration of ionized, in crossed-field devices, 17: 16887
action of uniform force field on, in transitory regime, isotopic separation during, 17: 16821
analysis of radioactive, chromatographic, 17: 15855(R) (ORNL-3397 (p.38-54))
book: *Physics of Fully Ionized Gases*, 17: 17386
electric discharge in low-density neutral, model for, 17: 17364
equilibrium distribution of relativistic, 17: 16781 (JINR-P-1159)
heat transfer in partially ionized diatomic, stagnation-point, 17: 16251
heat transfer to rarefied atmosphere, 17: 16250
ion pair production in, energy expenditure by beta, gamma, and x radiation and electrons for, 17: 16086
ionization by radiation from glow discharge, 17: 16812
kinetic theory of nonequilibrium, 17: 16864
separation of, by thermo-diffusion in porous medium, negative enrichment effect in, 17: 16491
theory of, linked-cluster expansions of partition functions in, 17: 17065
transport phenomena in moderate-density, 17: 16822
GASKETS
fabrication of custom, survey of methods for, 17: 16175 (LAMS-2799)
GASTROINTESTINAL TRACT
radiation effects on secretion functions, 17: 15838
GEIGER-MUELLER TUBES
characteristics, 17: 16443
characteristics, automatic recording of, 17: 16444
GELATIN
radioinduced free radicals in, effects of temperature on, 17: 15767
GENERATORS
plasma stream of arc, effects of polarity on, 17: 17385
GENETICS
effects of chronic, low-dose gamma exposure in mice, 17: 15686
factors affecting take of skin grafts in mice, 17: 15585
factors affecting radiation resistance in mice, 17: 15680
radiation effects on mutations and somatic anomalies in man, 17: 15665
radioinduced and spontaneous mutations in rhizobial plants, 17: 15649
use of radioinduced mutations in plant breeding programs for rice, 17: 15564
use of radioinduced mutations in plant breeding programs for rice, 17: 15566
GEOCHEMISTRY
applications of isotope effects in studies of, 17: 15554
GEOMAGNETIC FIELDS
boundary of, effect of uniform external pressure on, 17: 16291
charged particle motion in trapped, 17: 16921
compression by incident stream of ionized polar particles, model for mechanism of, 17: 16282
disorder and shocks in distant, 17: 16280
dynamics of distant model for, 17: 16281
effects on irregularities of ionization in ionosphere, 17: 16283
measurement of, search coil for, 17: 16389
metrology for, theory of, 17: 16263 (CEA-2035)
micropulsations near coastline, model for, 17: 16269
microstructure of disordered hydromagnetic medium in the collisionless limit, 17: 16281
GEOMAGNETIC STORMS
delay time of, relation to delay time of polar-cap blackout, 17: 16289
forecasts of, suggestion for improving, 17: 16290
hydromagnetic frequency cutoff in upper atmosphere by, 17: 16296
influence of moon on, 17: 16285
GEOPHYSICS
atomic-reaction effects in planetary atmospheres, 17: 16886
bibliography on, 1960 Russian, 17: 16266(T) (NASA-TT-F-109)
GERMANIUM
proton reactions (p,xn) at 120, 300, 480, and 600 Mev arsenic isotope yields from, 17: 17116 (JINR-P-1157)
radioinduced defects in, effect of dislocations and disordered regions on, 17: 16748
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
GERMANIUM ALLOYS
Ge–Sn–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Sb–Ge–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
GERMANIUM CRYSTALS
x-ray transmission, anomalous, 17: 16861(T)
GLASS
performance as vials for low-level-beta scintillation counting, 17: 16458
properties as neutron detector, 17: 16477(P)
properties of uranía-containing, at high temperatures, 17: 16525(R) (NYO-9736)
sputtering of, by krypton ions at 4 to 30 kev, cathode coefficient for, 17: 16817
use as neutron detector, 17: 16474(P)
glass–ThO_2, fabrication, 17: 17478(P)
glass–UO_2, fabrication, 17: 17478(P)
GLOBULIN
β-lacto-, oxygen effects on radiosensitivity of, 17: 15778
GLOW DISCHARGES
cathode fall region in d-c, dynamics of, 17: 16854
electromagnetic wave propagation by, at 500 to 4200 Mc, 17: 16889
radiation from, ionization of gases by, 17: 16812
GLUCOSE
radiosensitivity effects on glucose oxidase, 17: 15774
GLYCINE SULFATES
radiation effects on elastic and piezoelectric properties, 17: 16860(T)
GLYCOGEN
radiation effects on content of, in rat brain, 17: 15695
GOATS
radiation injuries, correlation of systemic and hematological recovery, 17: 15804 (USNRDL-TR-606)
GOLD
deuteron reactions (d,np) on, mechanisms for, 17: 17185
diffusion of hydrogen in, studies of, by d(d,p)T reaction, 17: 17289
effects on gas absorption by thorium-containing getter, 17: 16620(P)
electrical resistivity, residual due to defect pairs and tin impurities, 17: 16695
magnetoplasma resonance in, 17: 16841
proton reactions (p,n) at 5 to 12 Mev, neutron spectra from, 17: 17293
GOLD ALLOYS
Al–Au, use as tracer for process analyses, 17: 15913
Au–Ho, crystal structure, 17: 16658 (TID-18197)
Au–Nd, crystal structure, 17: 16658 (TID-18197)
Au–Ni, optical properties of films, 17: 16696
Au–Pr, crystal structure, 17: 16658 (TID-18197)
Au–Sm, crystal structure, 17: 16658 (TID-18197)
Au–Th, crystal structure, 17: 16658 (TID-18197)

Au–Tm, crystal structure, 17: 16658 (TID-18197)
Au–Y, crystal structure, 17: 16658 (TID-18197)
Dy–Au, crystal structure, 17: 16658 (TID-18197)
Er–Au, crystal structure, 17: 16658 (TID-18197)
Gd–Au, crystal structure, 17: 16658 (TID-18197)
GOLD ISOTOPES Au-193
energy level transition probabilities for, first, 17: 17193
GOLD ISOTOPES Au-195
energy level transition probabilities for, first, 17: 17193
GOLD ISOTOPES Au-197
electron inelastic scattering by, energy levels from, 17: 17233
energy level transition probabilities for, first, 17: 17193
fission by boron-11, carbon-12, nitrogen-14, and oxygen-16 ions, distributions from, 17: 17225
helium-ion fission of, product yields in, 17: 17224
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
neutron resonance capture rate of, analysis of activation measurements of, 17: 17107 (GA-3069)
reactions with carbon-12 and oxygen-16, compound nucleus formation cross sections for, 17: 17118 (JINR-P-1162)
GOLD ISOTOPES Au-198
activity measurements of, using coincidence method, 17: 16439
distribution of, in bone marrow, liver, spleen, and thymus of rats after intracardiac injection, 17: 15607
distribution of, in rabbits after intravenous injections, electrophoretic patterns of, 17: 15608
use for analyses of liver function, 17: 15611
use in studying reticulo-endothelial system of bone marrow, 17: 15715
GOLD ISOTOPES Au-199
decay of, internal conversion coefficients in, 17: 17238
decay scheme, 17: 15858(R) (ORNL-3397(p.71-112))
GONADAL HORMONES
effects on frogs exposed to radiation, 17: 15743
GONADS
radiation effects on chromosomes in sperm cells in mice, 17: 15637(R) (TID-18135)
radiation effects on Leydig cells in rats, 17: 15693
radiation effects on, in hormone treated frogs, 17: 15743
radiation effects on oocyte maturation in female mouse, 17: 15816(T)
radiation tolerance dose of ovaries, in animals and humans, 17: 15594
radioactive contamination of human, from fallout, 17: 16346
GRANITES
analysis for thorium and uranium, spectrophotometric, 17: 15861(R) (ORNL-3397(p.117-21))
GRAPHITE
analysis for aluminum and vanadium, activation, 17: 15916
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
development as reactor moderator material, 17: 17445
diffusion and evolution of xenon-133 from bulk, at 800 to 1600°C, 17: 16665(T,R) (EURAEC-363)
diffusion of xenon-133 in, mechanisms for, 17: 16744(R) (TID-18112)
electron microscopic studies of graphitized, 17: 16692
fission product release from, 17: 16690
mechanical properties of, determination at temperatures to 5000°F, 17: 16178(R) (TID-17887)
oxidation by air and carbon dioxide, 17: 15966(T) (NP-tr-958)
radiation and temperature effects on mechanical and physical properties of, 17: 16760
shear strength of AGOT, 17: 16659 (TID-18246)
stress of, in EGCR core, analysis of, 17: 17571 (TID-18251)
temperature distributions in, in EGCR, 17: 17550 (TID-18098)
thermal conductivity of molded and pyrolytic, at 1260 to 2200°K, 17: 16678
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
GRAPHITE COMPACTS
production of low-porosity, high-strength, 17: 16617(P)
GRAPHITE MODERATED REACTORS
containment and restraint devices for mobile, design, 17: 17487(P)
coolant pumps for large, design of drive for, 17: 17414 (HW-SA-2922)
core restraint garter design, 17: 17496(P)
fuel element loading of, design of equipment for, 17: 17518(P)
GRAPHITE POWDERS
properties of, electric and magnetic, 17: 16915
GRAPHITE SYSTEMS
graphite–He, density of, design of measuring device for, 17: 16386(R) (TID-18162)
graphite-N, density of, design of measuring device for, 17: 16386(R) (TID-18162)
GRAVITATION
field equations for gravitational energy radiation, 17: 16832
field quantization in, 17: 16826
interactions with electromagnetic waves, theory, 17: 16858
stability of an infinite system of mass points interacting under a Newtonian force, 17: 16831
GREASES
ablation of films of, 17: 16224 (GAMD-2237)
GROUND WATERS
flow direction determination using single bore hole and tracers, 17: 16268
radioactivity of, measurements in Federal Republic of Germany, April to June 1962, 17: 15625
treatment of, research progress in Belgium, 17: 17620(T,R) (EURAEC-518)
GUINEA PIGS
beryllium nitrate effects on skin of, injected, 17: 15598
radiation effects on 5-hydroxytryptamine content in small intestine in, 17: 15705
therapy of lethally irradiated, using bone marrow transplants, 17: 15839

H

HAFNIUM
melting effects on work hardening properties of, electron beam and inert gas arc, 17: 16712
neutron-shielding performance of, 17: 16731(P)
production and properties of, 17: 16707
separation of, from zirconium oxide ores, 17: 16533
solvent extraction using TBP, mathematical analysis of, 17: 16155
solvent extraction using TBP, optimum conditions for, 17: 16166
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
HAFNIUM ALLOYS
Fe–Hf, phase studies, 17: 16546
Hf–Ir, phase studies, 17: 17446
Hf–Nb–W, phase equilibria of niobium-rich regions, 17: 16641(R) (DRI-2091)
Hf–Pu, phase studies, 17: 16566
Hf–V, phase studies, 17: 17446
HAFNIUM BORIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
HAFNIUM CARBIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
HAFNIUM ISOTOPES Hf-180
energy level lifetimes in, 2+ and 4+, 17: 17219
HAFNIUM NITRIDES
emissivity, measurement of spectral, 17: 16632(R) (AD-274654)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
HAFNIUM OXIDES
radiation and temperature effects on mechanical and physical properties of, 17: 16760
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
HAFNIUM SYSTEMS
C–Hf–Fe, phase studies, 17: 16542
C–Hf–Nb–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
HAIR
activation by fast neutrons, use in SL-1 accident dose estimations, 17: 16315 (LADC-5359)
radiation effects on growth of, on mice, 17: 15822
strontium-90 uptake from injection into rats, 17: 15612
HALIDES
neutron capture in organic, mechanisms for reactions following radiative, 17: 16076

radioinduced radical production in ethyl, 17: 16038
HALL EFFECT
hydromagnetic frequency cutoff in ionosphere by, 17: 16296
HALLAM POWER REACTOR
fuel elements, shipment safety evaluation, 17: 16317 (NAA-SR-Memo-8151)
HANDBOOKS AND MANUALS
on molybdenum, 17: 16549
HANFORD PRODUCTION REACTORS (KE)
in-pile loop control and instrumentation, 17: 17593 (HW-SA-2945)
HANFORD PRODUCTION REACTORS (N)
materials for, development of, 17: 15532(R) (BMI-1607(Del.))
HARMONIC ANALYSIS
neutron transport in multilayer cylindrical geometry, spherical harmonics approximation of, 17: 17089 (CRT-1088)
HASTELLOY X
corrosion of, by steam at 1050°F, 17: 16587 (GEAP-4165)
radiation effects on, 17: 15532(R) (BMI-1607(Del.))
radiation effects on stress-rupture properties, 17: 16745 (TID-18150)
HAYNES 25 ALLOY
corrosion of, by rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
HEART
pericardial effusion of, method for radioisotope scintillation detection of, 17: 15582
radiation sickness effects on, in dogs, 17: 15840
HEAT
sources of, properties of radioisotopes as, 17: 16357 (HW-76323)
HEAT EXCHANGERS
design, 17: 16256(P)
design of, 17: 16255(P)
HEAT TRANSFER
ablation, value of grease films as protective coating in, 17: 16224 (GAMD-2237)
analysis of, for Piqua Power Reactor configurations, 17: 17544 (NAA-SR-Memo-7952)
coefficients and pressure drop measurements for n-butanol in tubes, 17: 16234 (UCRL-10527)
dynamics of, between radiating gas and rarefied atmosphere, 17: 16250
for turbulent boundary-layer flow longitudinal to circular cylinder, 17: 16242
from fuel rod bundles to water, 17: 17546(R) (SRO-80)
from fuel tubes to steam-water spray, 17: 17406(R) (EURAEC-519)
in boiling systems, lectures on, 17: 17403 (ANL-6640)
in fluidized beds, 17: 16249
in nuclear space power plants, problems of, 17: 16230(R) (PWA-2132)
in nucleate boiling of terphenyl coolants, effects of dissolved nitrogen on, 17: 16228 (NAA-SR-Memo-8064)
in rocket motor nozzles, 17: 17606 (NASA-TN-D-1578)
in steam-water spray-cooled reactors, design of facility for studying, 17: 17407(R) (EURAEC-537)
stagnation-point, in partially ionized air, 17: 16252
temperature factor effect on, in turbulent flow of gas in pipes, 17: 16236(T) (AERE-Trans-911(Pts.1&2))
theory of stagnation-point, in partially ionized diatomic gas, 17: 16251
to mercury flowing in-line through bundle of circular rods, coefficients for, 17: 16222 (BNL-6826)
tracer techniques in ablation, 17: 16223 (GAMD-2117)
HEAT TRANSFER SYSTEMS
design for reactors, 17: 16259(P)
ionization process, design for, 17: 16257(P)
HEAVY WATER REACTORS
development, 17: 17546(R) (SRO-80)
development, 17: 17419(R) (MITNE-26)
development of NORA, 17: 17555(R) (TID-18108)
economic prospects of power, 17: 17577
monitoring of insulating tube inside pressure tube, 17: 17513(P)
multiplication factor of, effects of light water on, 17: 17432
HELIUM
analysis for oxygen, comparison of methods for, 17: 15855(R) (ORNL-3397(p.38-54))
atomic structures of $1s2p$ electron configurations, 17: 16823
electric discharge in, helical instability in positive-column, 17: 17352
electric glow discharge in, electromagnetic waves from, 17: 16889
formation of central vortex in rotating liquid, 17: 16867
ionization of, characteristics of high-frequency ion source in, 17: 16800
light emission by excited, measurement of polarization of, 17: 16842
mutual friction between superfluid and normal components of liquid, along axis of rotation, 17: 16866
proton reactions on, ionization cross sections in, 17: 16886
purification and recirculation for plutonium fuel fabrication, design and operation of system for, 17: 16171 (ANL-6489)
testing for use in cooling systems for fuel handling casks, 17: 17545 (NAA-SR-Memo-8053)
thermal accommodation during adsorption of potassium and cesium on tungsten, 17: 16027
HELIUM IONS
fission of uranium-235 and uranium-238 by, study of valley region of mass yield curves for, 17: 17126 (TID-18165)
reactions on gas nuclei, ionization cross sections in, 17: 16886
reactions with gold 197, lead-204, and lead-206, fission product yields in, 17: 17224
reactions with rhenium and thorium, fission, 17: 17124 (TID-18131)
HELIUM ISOTOPES He-3
emission in deuteron reactions with argon-40 and zinc-68, cross section energy dependence on, 17: 17234
meson (μ^-) reactions, measurements of rate, 17: 17278
meson (μ^-) reactions with, calculation of rates of, 17: 17049
performance in thermonuclear space-propulsion systems, 17: 16891
proton elastic scattering and polarization by, at 4 to 13 Mev, 17: 17296
reactions (He^3,n) with boron, cross section curve from 2.0 to 6.3 Mev, 17: 17236
reactions with calcium-40, 17: 17218
thermal capacity of, effects of vapor pressure on, 17: 15952 (LADC-5711)
HELIUM ISOTOPES He-4
hyperon(Λ^0) binding energy in hypernucleus of, 17: 17175
thermal capacity of, effects of vapor pressure on, 17: 15952 (LADC-5711)
HELIUM ISOTOPES He-5
hyperon(Λ^0) binding energy in hypernucleus of, 17: 17175
HELIUM ISOTOPES He-6
nuclear density distribution of, shell models for, 17: 17176
HELIUM SYSTEMS
Ar–He, scintillation properties, 17: 16794 (UCRL-10523)
graphite–He, density of, design of measuring device for, 17: 16386(R) (TID-18162)
He–Xe, xenon atomic transitions in, 17: 17374
HEMATOPOIETIC SYSTEM
radiation effects on bone marrow aspiration and leukocyte production in, 17: 15820
HEMOGLOBIN
chromium-51 distribution among components and polypeptide chains of, 17: 15593
HEMORRHAGE
induced by irradiated beef diet in rats, 17: 16364(R) (NP-12602)
induced in rats maintained on irradiated beef diet, 17: 16360(R) (NP-12597)
HEPTANE
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)
HETEROGENEOUS REACTORS
design, 17: 17479(P)
design, 17: 17491(P)
design, 17: 17507(P)
fuel assembly arrangement for, 17: 17588(P)
HEXANE, 3-METHYL-
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)
HIGH-ALTITUDE EXPLOSIONS
detection of nuclear, at altitudes around 60,000 miles, 17: 16899
detection of nuclear, by lf and vlf methods, 17: 16900
effects of nuclear, on trapped-electron distributions, 17: 16875
effects of, observed at Jamaica, 17: 16297
effects of, observed near Los Angeles, 17: 16298
effects on path length and amplitude of myriametric waves, 17: 16272
ionization effects from, detection of, 17: 16292

HIGH ENERGY INJECTION DEVICES
design of coaxial plasma gun, 17: 17354
heating mechanisms in carbon-arc, 17: 17333(R) (ORNL-3392(p.47-8))
hydrogen molecular-ion beam dissociation in, 17: 17330(R) (ORNL-3392(p.1-10))
ion acceleration and injection at DCX-2, 17: 17334(R) (ORNL-3392 (p.49-55))
plasma decay and formation in, 17: 17331(R) (ORNL-3392(p.11-27))
HIGH TEMPERATURE GAS COOLED REACTOR EXPERIMENT
development of, role of irradiation experiments in, 17: 17437
fuel element irradiation testing, design of facility for, in DIORIT, 17: 16755
HIGH TEMPERATURE SEPARATION PROCESSES
development for reactor fuels, review, 17: 17452
HIPPURIC ACID, AMINO-, SODIUM SALTS
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668
HIPPURIC ACID, *o*-IODO-, SODIUM SALTS
stability of iodine-131-labeled solutions, 17: 15699
HIROSHIMA
leukemia incidence in bomb survivors in, from 1946 to 1960, 17: 15825
HISTIDINE
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668
HOLMIUM
content of, in marine organisms, 17: 15604
neutron capture in, gamma energies from thermal, 17: 17181
HOLMIUM ALLOYS
Ag–Ho, crystal structure, 17: 16658 (TID-18197)
Au–Ho, crystal structure, 17: 16658 (TID-18197)
HOLMIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
HOLMIUM IONS
energy levels of negative, quasi-discrete, 17: 16835
HOLMIUM ISOTOPES Ho-165
photoneutron cross sections of, 17: 17227
proton fission at 150-Mev, relative yields for, 17: 16052(R) (TID-18261 (p.44-8))
HOLMIUM ISOTOPES Ho-166
gamma emission, 17: 17181
gamma spectra, 17: 17165
HOMOGENEOUS REACTORS
design of apparatus for startup or shutdown of slurry, 17: 17523(P)
fission gas removal from, system for, 17: 17526(P)
vapor removal from core of, method for, 17: 17520(P)
HUMIC ACIDS
complex with uranium, 17: 15968
HUMIDITY
measurements of, at building sites using neutron source, 17: 15903
HYDRAZINE
radiolysis of solid, production of radicals in, 17: 16093
spectra of deuterated and normal, infrared and Raman, 17: 16009(T)
HYDRIDES
development as reactor moderator material, 17: 17445
identification by photoneutron reactions, 17: 16332(R) (UCRL-7143)
HYDROAROMATIC COMPOUNDS
polarographic oxidation potentials, 17: 16033 (TID-18149)
HYDROCARBONS
analysis for hydrogen by neutron absorption or reflection, 17: 15891(T) (CEA-tr-A-1245)
hydrodesulfurization of, radiation effects on catalytic activity in, 17: 16117(P)
HYDROCHLORIC ACID
corrosive effects on construction materials for fuel processing plants, 17: 17451
separation of, from neptunium, plutonium, and uranium using tri-octylamine, 17: 16156
HYDRODYNAMICS
liquid film thickness, phase and velocity distributions, and pressure drop in steam-water spray test loops, 17: 17406(R) (EURAEC-519)
vorticity in fluids embedded in magnetic fields, 17: 17397
HYDROFLUORIC ACID
corrosive effects on construction materials for fuel processing plants, 17: 17451
separation of elements from, by ion exchange, determination of optimum conditions for, 17: 16152
HF-water, proton magnetic resonance, relations of concentration with proton chemical shifts, 17: 15963 (TID-18200)
HYDROGEN
bremsstrahlung reactions at 160, 170, and 185 Mev, meson (π^0) production in, 17: 17082
determination in alkali metals, gas chromatographic, 17: 15855(R) (ORNL-3397(p.38-54))
determination in hydrocarbons by neutron absorption or reflection, 17: 15891(T) (CEA-tr-A-1245)
deuteron reactions (d,np) at 7 to 12 Mev, neutron spectra, 17: 17086
diffusion in gold, silver, and copper, studies of, by means of d(d,p)T reaction, 17: 17289
effects on mechanical properties of niobium, 17: 16728
electric charge of neutral molecular, upper limits for, 17: 17012
electric discharge in, model for, 17: 17364
electron inelastic scattering by atomic, Born cross sections for, 17: 16848
electron scattering cross section for, behavior near 2s excitation level threshold, 17: 17270
gamma reactions at 350 to 6000 Mev, photoproduction of 300-Mev effective mass particles in, 17: 17109 (ISS-62/27)
gamma reactions at 500 to 6000 Mev, photoproduction of 400-Mev effective mass particles in, 17: 17110 (ISS-62/28)
gamma reactions at 650 to 6000 Mev, photoproduction of 500-Mev effective mass particles in, 17: 17111 (ISS-62/29)
gamma reactions at 800 to 6000 Mev, kinematics of particle production in, 17: 17112 (ISS-62/30)
gamma reactions at 725 to 1500 Mev, meson (η^0) production in, 17: 16946 (ISS-62/15)
gamma reactions at 187 Mev, angular distribution of mesons (π) from, 17: 16985
helium-ion and proton reactions on, ionization cross sections in, 17: 16886
hyperfine structure in atomic, state-dependent mass corrections to, 17: 16847
ionization of, characteristics of high-frequency ion source in, 17: 16800
ionization of neutral, collisional excitation cross sections for, 17: 17342 (UCRL-7115)
meson (π^-) absorption and moderation in liquid, 17: 17230
neutron diffusion in, fast, 17: 17460
oxidation rate in electrolysis, 17: 16493
photon reactions with, production of mesons (π^+) in, 17: 17084
production of activated forms at very low temperature, 17: 15864
reactions with Zircaloy-2, effects of stress on, 17: 15958 (TID-16476)
separation of deuterium from, by reaction with alkali metal, 17: 16501(P)
sorption of, by Zircaloy in reactors, 17: 16598
spectra of, heterogeneous perturbations in absorption, 17: 15977
spectra of, isotopic effects on Λ doubling in absorption, 17: 15978
sticking factors for, on titanium film, 17: 17337(R) (ORNL-3392 (p.86-8))
yields in radiolysis of organic liquid mixtures, 17: 15768
HYDROGEN IONS
accelerator design for negative, 17: 17319 (TID-18223)
dissociation of molecular, in DCX, 17: 17330(R) (ORNL-3392(p.1-10))
dissociation of molecular, in DCX, 17: 17331(R) (ORNL-3392(p.11-27))
dissociation of molecular, in magnetic mirrors, 17: 17338(R) (ORNL-3392(p.89-93))
dissociation of, molecular, in electric fields, 17: 16793(R) (TID-18265)
energy levels of negative, quasi-discrete, 17: 16835
extraction of negative, from duo-plasmatron source, 17: 16833
HYDROGEN ISOTOPES
separation by ammonia-hydrogen exchange, prevention of catalyst accumulation in, 17: 16497(P)
separation by electrolysis, reaction rates in, 17: 16493
separation of, by low-temperature continuous distillation, pilot-scale still for, 17: 16490 (DP-732)
separation of, electrolytic refining process for, 17: 16489 (DP-261)

HYDROGEN ISOTOPES H-4
hyperon(Λ^0) binding energy in hypernucleus of, 17: 17175
HYDROGEN PEROXIDES
radioinduced formation and decomposition, effects of pH on, 17: 16058(T) (AEC-tr-5687)
radiosensitivity effects on paramecia, 17: 15737
HYDROGEN TELLURIDES
combustion of, for tellurium aerosols generation, 17: 15939 (AERE-M-1130)
HYDROMAGNETIC WAVES
coupling to electromagnetic waves at plasma discontinuity, 17: 17363
disturbances and turbulence in magnetopause, 17: 16280
frequency cutoff in upper atmosphere, 17: 16296
perturbations of, solutions for nonisentropic, 17: 16510
properties of magnetoplasma resonances in metals, 17: 16841
HYDROXIDE COMPLEXES
formation in metal-oxy acid reactions, 17: 15918
HYPERFRAGMENTS
binding energy of $_{\Lambda}H^3$ and $_{\Lambda}H^4$, 17: 17014
hyperon(Λ^0) binding energies in $_{\Lambda}H^4$, $_{\Lambda}He^4$, $_{\Lambda}He^5$, and $_{\Lambda}Li^6$, 17: 17175
lifetime of $_{\Lambda}He^4$, $_{\Lambda}He^5$, and $_{\Lambda}He^7$, 17: 17202
meson (π^+) decay of $_{\Lambda}He^4$, 17: 17190
production in meson (K^-) reactions with emulsion nuclei at 1.3 and 1.5 Mev/c, 17: 17191
HYPERONS
interactions with mesons (π), hyperons (Y*) from, 17: 16995
interactions with borons, mass splitting in strong and weak, 17: 17016
interactions with mesons (π), coupling constants for, 17: 17025
interactions with baryons and mesons, Regge asymptotic amplitudes for, 17: 17046
leptonic decay of, unitary symmetry and, 17: 16963
parities and spins of excited baryons, determination of, 17: 17002
parity and spin of Y_1^*, 17: 17040
production by antinucleon annihilation in meson (π)-nucleon and nucleon-nucleon collisions, 17: 16953 (JINR-P-1163)
properties of 1.66-Bev Y_1^*, 17: 17041
resonance effects of Y_1^*, on K^--p interactions at 760 Mev/c, 17: 17042
resonance $\frac{1}{2}^-$, fitting N_1^*, Y_1^*, Y_0^*, and Ξ^* to octet model of, 17: 16993
spin of (Y_1^*), 17: 17039
theory, eightfold-way assignments in, 17: 17043
HYPERONS (Λ)
beta decay of, electron-proton angular correlations in, 17: 16982
decay of, angular correlations for mesons (π), 17: 16984
decay of, energy spectrum of protons in, 17: 16983
interactions with mesons (π), parity and spin of Y_0^* from, 17: 17040
interactions with mesons (π), 1.66-Bev Y_1^* from, 17: 17041
HYPERONS (Λ^0)
binding energies in $_{\Lambda}H^4$, $_{\Lambda}He^4$, $_{\Lambda}He^5$, and $_{\Lambda}Li^6$, 17: 17175
interactions with nucleons in $_{\Lambda}H^3$ and $_{\Lambda}H^4$, 17: 17014
interactions with mesons (π), hyperon (Y_1^*) spin from, 17: 17039
interactions with mesons (π), theory for hyperons (Y_1^*) from, 17: 17043
HYPERONS (Σ)
decay of, selection rules for non-leptonic, 17: 17000
HYPERONS (Σ^-)
capture by deuterium, impulse approximation for, 17: 17240
interactions with deuterons and protons at low energies, meson (π)-hyperon coupling constants for, 17: 17025
HYPERTHYROIDISM
therapy of, dosimetry of iodine-131 in, 17: 15552
HYPOPHOSPHITES
use of, for fixation of fission product ruthenium in waste solids, 17: 17618 (ORNL-TM-263)
HYPOPHOSPHOROUS ACID
deuterium exchange with water, kinetics, 17: 15988

I

IMAGE BRIGHTNESS INTENSIFIERS
conference on photo-electronic image devices, 17: 16394
IMIDAZOLINES
2-benzyl-, radiation effects on toxicity of, on mice, 17: 15678
IMMUNITY
book: *Immunology in Acute Radiation Sickness*, 17: 15848
polonium effects on, in dogs, 17: 15815(T)
radiation effects on *Trichinella spiralis*, in mice, 17: 15654
radiation effects on, in rats, 17: 15761
reactions to skin grafts in mice, 17: 15758
suppression of response to antigens in mice by anti-tumor agents, 17: 15584
IMMUNIZATION
radiation effects on, in rats, 17: 15644 (USNRDL-TR-605)
radiosensitivity of response to allogenic and xenogenic skin grafts in mice, 17: 15646 (USNRDL-TR-619)
IMPELLERS
cavitation studies of mixed-flow pump, 17: 16244
IN-PILE LOOPS
control and safety systems for, 17: 17593 (HW-SA-2945)
decontamination of internal surfaces, solutions for, 17: 15868(P)
design of, for irradiation of organic liquids, 17: 16074
design of helium-cooled, for irradiation of fuel elements, 17: 16756
development for EOCR research, 17: 17416(R) (IDO-16830)
development of, for studies of fog-cooled reactors, 17: 17407(R) (EURAEC-537)
INCOMPRESSIBLE FLOW
analysis of viscous, 17: 16225 (GAMD-2257)
INCONEL
corrosion of, by steam at 1050°F, 17: 16587 (GEAP-4165)
corrosion of, in pressurized water reactors, 17: 16598
fatigue in, effect of stress state on high-temperature low-cycle, 17: 16654 (ORNL-3398)
INCONEL X
mechanical properties at 1100°F, 17: 17411(R) (GEMP-177C)
radiation and temperature effects on mechanical and physical properties of, 17: 16760
INDEXES
cumulative coordinate, for bibliographies on radiation effects on solid uranium-based nuclear fuel materials, 1961 and 62, 17: 16747 (VDIT-16(Ind.61/62))
INDIA
atomic energy developments in, 1962, 17: 15533(R) (NP-12645)
geochemistry of natural waters in uranium deposit at Umra, Rajasthan, 17: 16303
radiation processing of foods, developments, 1962, 17: 16375
INDIAN POINT POWER REACTOR
description, 17: 17582
INDIUM
alloying effects on titanium, 17: 16580(P)
proton fission at 40, 60, 100 and 140 Mev, cross sections, relative yields and mass distribution from, 17: 16053(R) (TID-18261(p.49-60))
separation of, from cobalt, manganese, nickel, and zinc, using cinnamic acid, 17: 15924
sorption of, by lithium, magnesium, potassium, and sodium halides, 17: 15992
INDIUM ALLOYS
In–Pu, preparation, 17: 16568
INDIUM CHLORIDES
chlorine-36 exchange from, to nitrosyl and phosphoryl chlorides, 17: 15996
INDIUM ISOTOPES In-114
sorption of, by lithium, magnesium, potassium, and sodium halides, 17: 15992
INDIUM ISOTOPES In-115
alpha reactions (α,2p) with, production of indium-117 isomers in, 17: 16048(R) (TID-18261(p.15-18))
electron inelastic scattering by, 17: 17233
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
proton reactions (p,n) on, spectra from, 17: 17226
INDIUM ISOTOPES In-117
isomeric states of, production in (α,2p) reactions in indium-115, 17: 16048(R) (TID-18261(p 15-18))
INDOLE
radiosensitivity effects in mice, 17: 15842
INDOLE,3-(2-AMINOETHYL)-

protective effects of, against radiation in mice, 17: 15826
3-INDOLEACETIC ACID
radiation effects on, 17: 15776
radiosensitivity effects in mice, 17: 15842
5-INDOLOL, 3-(2-AMINOETHYL)-
radiation effects on content of, in small intestine in guinea pigs, mice, rabbits, and rats, 17: 15705
radiosensitivity effects on tumor cells, 17: 15747
radiosensitivity effects of, on mammals, 17: 15753
INFECTIONS
cortisone and x-radiation effects on *Trypanosoma lewisi*, in rats, 17: 15573
effects on phagocytic capacity of reticuloendothelial system, 17: 15572
immunity to, effects of radiation on, 17: 15848
INFLUENZA VIRUS
radiation effects on hemagglutinin and infectivity of, protective effects of chemicals against, 17: 15668
INFRARED SPECTROSCOPY
development of, for analytical uses, 17: 15862(R) (ORNL-3397(p.121-3))
INSECTICIDES
effectiveness and toxic effects in man, tracer studies, 17: 15559
INSECTS
control by radiation sterilization of males, 17: 15561
control of fruit fly by irradiation sterilization, 17: 15560
physiology and ecology, tracer studies, 17: 15559
radiation control of fruit flies, 17: 15562
radioactive fallout fixation by ants, 17: 15620
radiosterilization of houseflies, effectiveness of, 17: 15751
INSTRUMENTATION
environmental effects on, in nuclear rockets, 17: 16384 (LADC-5679)
INSTRUMENTS
design and operation of, for high-altitude velocity measurement, 17: 16320(R) (NYO-9675)
nuclear, developments in Britain, 17: 16388
INTESTINE
polonium effects on microflora in, in dogs, 17: 15815(T)
radiation effects on epithelium, 17: 15632(R) (ORO-584)
radiation effects on micromotility of small, in dogs, 17: 15683
radiation effects on epithelium of, in white mice, 17: 15746
radiation effects on 5-hydroxytryptamine content in, in guinea pigs, mice, rabbits, and rats, 17: 15705
radiation effects on rectum and sigmoid colon, therapeutic, 17: 15807
IODIDE IONS
protective effects against radiation in DNA solutions, 17: 15792
reduction of neptunium by, kinetics of, 17: 16003
IODINE
heat of vaporization of, measurement of, by labeling and counting, 17: 16326(R) (ORNL-3401(p.39-43))
metabolism by rats, mice, dogs, and monkeys, tracer study, 17: 15588 (LADC-5209)
photochemical reactions with organic compounds, 17: 16038
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
proton reactions at 100 Mev, isomeric state from, 17: 17141
removal from air by sorption on copper, 17: 16008
thyroid metabolism in infants, tracer study, 17: 15600
uptake of, by thyroid gland, rate and turnover of, 17: 15605
IODINE ISOTOPES I-131
contamination of milk by, effects of, on iodine uptake by thyroid gland, 17: 15605
content in Norwegian milk during 1961, 17: 15614 (A/AC.82/G/L.810)
determination of, in feces, method for direct, 17: 15904
dosimetry of, in treatment of hyperthyroidism, 17: 15552
hematologic effects of therapeutic doses, 17: 15696
uptake by pine trees, effects of soil sterilization with methyl bromide, 17: 15735
uptake in infants, 17: 15600
use for analyses of liver function, 17: 15611
utilization of, in diagnosis of thyroid disorders, review of, 17: 15550
IODINE ISOTOPES I-132
protective effects of, in pathological study of thyroid gland, 17: 15568
IODINE ISOTOPES I-133
protective effects of, in pathological study of thyroid gland, 17: 15568
ION BEAMS
extraction of negative hydrogen, from duo-plasmatron source, 17: 16833
production of, by impact of noble gas ions with gas to be ionized, 17: 17253
sputtering reactions with metals, breakdown as function of angle of incidence in, 17: 16818
ION EXCHANGE
of plutonium from nitric acid–water systems, effects of ion concentrations, 17: 16143 (LADC-5377)
ION EXCHANGE MATERIALS
sorptive properties for cesium-sodium systems, 17: 17615(R) (HW-76262)
sorptive properties for cesium-sodium systems, 17: 17615(R) (HW-76262)
sorptive properties of Linde 4A zeolite for strontium, 17: 17615(R) (HW-76262)
ION EXCHANGE PROCESSES
development for reactor fuels, review, 17: 17451
ION PAIR PRODUCTION
energy expenditure in gases by beta, gamma, and x radiation and electrons for, 17: 16086
ION SOURCES
characteristics of high-frequency, 17: 16800
design for propulsion, 17: 16873
design of 600-kv, 17: 17334(R) (ORNL-3392(p.49-55))
design studies of monocapillary emitter for, in thermionic converter, 17: 16773(R) (EDR-3207)
development of curvilinear-flow, 17: 17605(R) (N62-11311)
development of, for propulsion, 17: 16872
duo-plasmatron, extraction of negative hydrogen from, 17: 16833
IONIZATION
effects on radio wave propagation, 17: 15536
thermal equilibrium in gases, evolution, 17: 16827
IONIZATION CHAMBERS
design and performance of gamma radiation- and neutron-sensitive, 17: 17410 (GEAP-3914)
design of free-air, 17: 16423 (ISS-62/9)
design of free air, for measuring x rays produced by currents at 50 to 400 kv, 17: 16424 (ISS-62/10)
design of gas-filled, 17: 16480(P)
design of thermal-neutron-sensitive, 17: 16481(P)
development, 17: 17411(R) (GEMP-177C)
development for space radiation dosimetry in phantom, 17: 16452
electric potential and field distributions in, survey of, 17: 16462
performance of fast, for alpha activities, 17: 16446
IONOSPHERE
disturbances in, due to fast moving artificial satellites, 17: 16863
hydromagnetic frequency cutoff in, 17: 16296
ionization in, effects of geomagnetic field on irregularities of, 17: 16283
model for quiet, 17: 16284
perturbations by high-altitude nuclear explosions, 17: 16900
processes in, 17: 16307
proton source in, charge exchange as dominant, 17: 16928
IONS
acceleration, injection, and production of, at DCX-2, 17: 17334(R) (ORNL-3392(p.49-55))
correlations of, effect on high-frequency plasma conductivity by, 17: 17358
diffusion across magnetic field in plasma, Brownian motion treatment of, 17: 17340 (TID-18115)
interactions with electrons, pair correlation functions for, 17: 17350
interactions with ions, pair correlation functions for, 17: 17350
reactions of heavy, cross sections for compound nucleus formation in, 17: 17118 (JINR-P-1162)
scattering of heavy, quasi-classical treatment of elastic, 17: 17115 (JINR-P-1153)
scattering of heavy, investigation of elastic, 17: 17123(R) (TID-18127)
spectral line widths due to, calculation of, 17: 17324 (GAMD-927)
transport number of, testing bubble cell center-of-gravity-change method of measuring, 17: 15965(R) (TID-18273)
IRIDIUM ALLOYS
Hf–Ir, phase studies, 17: 17446

IRIDIUM ISOTOPES Ir-185
decay schemes, 17: 17213
IRIDIUM ISOTOPES Ir-186
decay schemes of 15.8-hour, 17: 17213
IRIDIUM ISOTOPES Ir-187
decay schemes, 17: 17213
IRIDIUM ISOTOPES Ir-188
energy levels, 17: 17150
IRIDIUM ISOTOPES Ir-192
determination of, as contaminant in yttrium-90 radioapplicator, 17: 15911
gamma spectra, 17: 17165
IRIDIUM ISOTOPES Ir-194
gamma spectra, 17: 17165
IRON
alloying effects on titanium, 17: 16580(P)
corrosion at 25 and 250°C in oxygen and water, microgravimetric measurement of, 17: 16585(R) (EURAEC-569)
corrosion in neutral and weakly alkaline water, erosion, 17: 16600
corrosion in oxygen-containing aqueous media, 17: 16599
determination in neptunium by ion exchange and spectrography, 17: 15896
determination in ocean-bottom cores by activation analysis, 17: 15886 (TID-18125)
determination in terphenyl by x-ray emission spectroscopy, 17: 15897
determination in uranium and uranium compounds, absorptiometric method for determination of, 17: 15879 (PG-Report-276)
determination of, in uranium fission products, 17: 15892
determination of, in ores, x-ray spectrum, 17: 15900
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
deuteron elastic scattering at 6.5 Mev, polarization, 17: 17263
ferromagnetic properties, 17: 16699
melting effects on work hardening properties of, electron beam and inert gas arc, 17: 16712
meson (μ) decay in, 17: 17297
meson (μ^-) scattering by magnetized, polarized 8-Bev, 17: 17017
mesons (μ) scattering, 17: 17228
neutron capture gamma spectra, 17: 17255
neutron elastic scattering by, 17: 17094 (TID-18277)
photon elastic scattering at particle threshold energy, cross sections for, 17: 17153
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
thermal expansion and structure, x-ray studies, 17: 16667
IRON ALLOYS
Al–Be–Fe, structure of phases, 17: 16691
Al–Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Cr–Fe–Ni–Ti, precipitation processes in, 17: 16718
Al–Cr–Fe–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Fe, radiation effects on, 17: 16541
Be–Fe, magnetic properties of, 17: 16704
Be–Fe, structure of phases, 17: 16691
Cr–Fe, diffusion of fission products in and release from, 17: 16638 (BMI-1611)
Cr–Fe, radiation effects on, 17: 16541
Cr–Fe, tensile properties, 17: 16640 (DMIC-Memo-164)
Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Cr–Fe–Ni, corrosion of, by steam at 1050°F, 17: 16587 (GEAP-4165)
Cr–Fe–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Cr–Fe–Pu, fabrication for high-temperature fuels, 17: 15532(R) (BMI-1607(Del.))
Cr–Fe–Zr, phase studies, 17: 16545
Cu–Fe, oxidation, 17: 16667
Fe–Hf, phase studies, 17: 16546
Fe–Mn, electronic specific heat, 17: 16698
Fe–Ni, electronic specific heat, 17: 16698
Fe–Ni, radioinduced order-disorder transitions, 17: 16701
Fe–Pu, phase diagrams, 17: 16566
Fe–Pu, phase diagram, 17: 16567
Fe–Zr, phase studies, 17: 16544
IRON CARBONYLS
corrosion at 25 and 250°C in oxygen and water, microgravimetric measurement of, 17: 16585(R) (EURAEC-569)
infrared spectra, 17: 15962 (TID-18199)
proton magnetic resonances of, in liquid hydrogen fluoride, 17: 15962 (TID-18199)
IRON(II) CHLORIDES
neutron scattering near Neel temperature, cross section for small-angle slow, 17: 16006
IRON COMPACTS
Fe–Mo, fabrication, 17: 15532(R) (BMI-1607(Del.))
IRON(II) COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
IRON(II) IONS
radioinduced oxidation of, in aqueous solutions with antimony(III) ions, 17: 16080
IRON(III) IONS
nuclear spin hamiltonian of $^6S_{5/2}$ states of, in crystals, 17: 17210
IRON ISOTOPES Fe-54
neutron inelastic scattering at 0.80 to 4 Mev, 17: 17473
IRON ISOTOPES Fe-55
production of, by 16-Mev cyclotron in Yugoslavia, 17: 17321
IRON ISOTOPES Fe-56
Coulomb excitation of, reorientation effects in, 17: 17140
lifetime of the 0.845-Mev level in, 17: 17265
neutron inelastic scattering at 0.80 to 4 Mev, 17: 17473
neutron resonance absorption and scattering at 28 kev, 17: 17468
IRON ISOTOPES Fe-57
gamma spectra of, relativistic effects on Mössbauer, 17: 17208
IRON OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
IRON(II) SULFATES
use of, for determination of isodose curves of 2000-curie gamma source, 17: 15578
IRON SYSTEMS
C–Fe–Pu, use as reactor fuel, 17: 16577(P)
C–Hf–Fe, phase studies, 17: 16542
Fe–Nb–P, phase studies of, 17: 15971
Fe–Si, phase transition behavior of, impulsive loading effects on, 17: 16649 (LADC-5396)
IRON TITANATES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
Al_2O_3–Fe_2TiO_5, emissivity of, measurements of, 17: 16787(R) (PWA-2163)
IRRADIATION FACILITIES
description of 50,000-curie cobalt-60, for sterilization of hypodermic syringes, 17: 16376
design and operation of, for gamma irradiations, 17: 16754
design and operation of, for DIORIT and SAPHIR, 17: 16754
design of, for DRAGON fuel element irradiation testing in DIORIT, 17: 16755
ISOTOPE EFFECTS
theory of second-order shift effects on nuclear radius of interaction, 17: 16803
ISOTOPE SEPARATION METHODS
centrifugal, design of ultracentrifuge for, 17: 16495(P)
development of continuous distillation at 21.7°K, 17: 16490 (DP-732)
electromigration in fused salts, apparatus for, 17: 16496(P)
exchange, design of system for hydrogen-liquid ammonia, 17: 16497(P)
flame spraying of solution of lithium salts, 17: 16499(P)
ion exchange, equations for column operation, 17: 16492
ISOTOPES
separation by thermo-diffusion, negative enrichment effect in, 17: 16491
ISOTOPIC EQUILIBRATION
applications in studies of biological and geological processes, 17: 15554
ISOTOPIC EXCHANGE
applications in studies of biological and geological processes, 17: 15554
ITALY
environmental radioactivity, July to December 1961, 17: 15615 (BIO/06/62)

J

JAWS
radiation effects on buccal cells in rabbit, sensitizing effects of testosterone on, 17: 15666
JET ENGINE FUELS
radiation effects, 17: 16107
JETS
velocity distributions from turbulent mixing of axisymmetric compressible, in half-jet region with quiescent air, 17: 16177 (SC-4764(RR))

K

KEROSENE
TBP-kerosene, analysis for uranium by x-ray fluorescence, 17: 15883 (PG-Report-428)
KIDNEYS
radiation effects on glomerulus and proximal tubule of, in mice, 17: 15712
radiation effects on cytoplasm of distal tubule cells of, in mice, 17: 15713
radiation injury as function of radiation dose, 17: 15709
radioactive contamination of human, from fallout, 17: 16346
KILNS
design of rotary, for uranium oxide reduction, 17: 16128(P)
KRYPTON
determination in reactor test capsules, chromatographic, 17: 15855(R) (ORNL-3397(p.38-54))
purification method for, 17: 15855(R) (ORNL-3397(p.38-54))
thermal accommodation during adsorption of potassium and cesium on tungsten, 17: 16027
triton ranges and stopping cross sections in, 17: 17212
KRYPTON FLUORIDES
preparation and properties of tetra-, 17: 16021
KRYPTON IONS
reactions on metals, secondary electrons from, 17: 16836
reactions with boron fluoride at 30 kev, production of fluorine ion beams in, 17: 17253
sputtering reactions with glass, mica, and quartz at 4 to 30 kev, 17: 16817
KRYPTON ISOTOPES Kr-85
penetration of ions of, into single-crystal silicon during glow discharge, 17: 16870
use of clathrate for preparing radiation sources, 17: 16217(P)

L

LABORATORIES
helium atmosphere system for plutonium-processing, 17: 16171 (ANL-6489)
LANTHANUM
content of, in marine organisms, 17: 15604
separation from neodymium, terbium, and thulium, 17: 16149(T) (CEA-tr-1230)
LANTHANUM ALUMINATES
gadolinium paramagnetic resonance spectrum in, 17: 16016
LANTHANUM BORIDES
electric conductivity of hexa-, 17: 16726
optical properties of hexa-, 17: 16714(T)
LANTHANUM CARBONATES
preparation by precipitation, 17: 15951 (LADC-5579)
thermal decomposition of, compound formations in, 17: 15951 (LADC-5579)
LANTHANUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
LANTHANUM ISOTOPES La-139
proton reactions (p,3n), cerium-137 isomeric cross section ratios from, 17: 16054(R) (TID-18261(p.61-70))
LANTHANUM OXIDES
analysis of, for cerium, neodymium, praseodymium and samarium, spectrographic, 17: 15932
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
effects of, on magnetic properties of magnesium manganese ferrates, 17: 16019
LEAD
determination of, in uranium fission products, 17: 15892
gamma scattering by, radiographic intensification factors for, 17: 17394
magnetoplasma resonance in, 17: 16841
meson (μ) decay in, 17: 17297
neutron elastic low-angle scattering at 14.2 Mev, 17: 17097
neutron elastic scattering by, 17: 17094 (TID-18277)
specific heat of normal and superconductive, between 0.3 and 4°K, 17: 16834
superconductivity of copper films in contact with superconducting, 17: 16830
LEAD ALLOYS
Pb–Pu, phase diagram, 17: 16567
LEAD COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
LEAD ISOTOPES
stability of radiogenic, effect of oxidation state of uranium, 17: 16301
LEAD ISOTOPES Pb-204
determination of, spectrometric, 17: 15905
helium-ion fission of, product yields in, 17: 17224
LEAD ISOTOPES Pb-206
helium-ion fission of, product yields in, 17: 17224
LEAD ISOTOPES Pb-208
electron inelastic scattering by, 17: 17233
energy levels in, shell-model configurations for two-hole two-particle, 17: 17138
proton elastic and inelastic scattering at 31 Mev, angular distributions and cross sections, 17: 17292
LEAD ISOTOPES Pb-210
separation from ethylenediamine acetate solutions, electrolytic and chemical, 17: 16150(T) (CEA-tr-A-1291)
LEAD SULFATES
properties as ion exchanger, 17: 16030(P)
LEAVES
nutrient uptake by, effects of wetting agents, 17: 15557
radiation effects on cell growth, 17: 15651
strontium and phosphorus uptake by, tracer study, 17: 15590(R) (TID-18161)
LECTURES
on dynamic behavior of boiling-water reactors, Netherlands-Norwegian Reactor School, Kjeller, Norway, Aug. 20 to 31, 1962, 17: 17417 (KR-35(Vol.I))
on dynamic behavior of boiling-water reactors, Netherlands-Norwegian Reactor School, Kjeller, Norway, Aug. 20 to 31, 1962, 17: 17418 (KR-35(Vol.II))
on many-body problem, 17: 17060
on principles of classical dynamics, 17: 16786 (NYO-10250)
on reactor technology, 17: 17403 (ANL-6640)
on selected topics in nuclear theory, 17: 17302
LEPTONS
interactions with nucleons, lecture on theory of weak, 17: 17302
interactions with nucleons, theory of weak, 17: 17309
LEUKEMIA
incidence of, in Hiroshima bomb survivors from 1946 to 1960, 17: 15825
radiation effects on incidence and latent period of, in mice, 17: 15724
radiation effects on incidence of, in Japan, 17: 15829
radiation effects on incidence of, in man, 17: 15834
radioinduced, in mice, biometrical studies of, 17: 15846
treatment of, by whole-body radiation followed by bone marrow infusions, case studies of, 17: 15546
treatment of chronic lymphocytic with phosphorus-32, summary of 161 patients, 17: 15697
LEUKOCYTES
radiation effects on, protective effects of ribonucleic acid against, 17: 15692
radiation effects on production of, 17: 15820
LEUKOPENIA
radioinduced in man, prognostic significance of, 17: 15819
LEVEL INDICATORS

design of radiometric, 17: 16398(P)
LIGHT
effects of, on mutations in *Neurospora crassa*, far-red and red, 17: 15652
polarization of, method for measuring, 17: 16842
propagation, effects of magnetic field, 17: 16974
LIGHT SOURCES
development of spark, for vacuum ultraviolet operation, 17: 16383 (JÜL-88-PP)
LIGNITES
uranium recovery from, by acid leaching, 17: 16153
LIPIDS
radiation effects on free radicals in, in rat liver, 17: 15672
radiation effects on, in chicken egg yolks, 17: 15723
LIQUID METAL COOLED REACTORS
development of fast, 17: 17409(R) (GEAP-3811)
development program for large, 17: 17542 (NAA-SR-3740)
fuel handling cask, cooling system for, 17: 17545 (NAA-SR-Memo-8053)
LIQUID METAL FUEL REACTOR
development, 17: 17404(R) (BNL-164)
LIQUIDS
measurement of radioactive, development of equipment and procedures for, 17: 16185
LITHIUM
atomic structures of $1s^2 2p^3$ electron configurations, 17: 16823
determination in beryllium oxide, flame photometric, 17: 15861(R) (ORNL-3397(p.117-21))
diffusion into semiconductors by drifting method, 17: 16898
hyperfine interaction in, effect of correlation on, 17: 16846
photoproton angular and energy distributions from, at 140 to 190 Mev, 17: 17295
LITHIUM ALUMINATES
density and porosity of, method for determining, 17: 15954 (PG-Report-352)
LITHIUM BORATES
spectra in vapor, infrared, 17: 15945 (AROD-006.8)
vaporization phenomena of, mass-spectrometric study of, 17: 15944 (AROD-006.7)
LITHIUM BROMATES
preparation, 17: 15859(R) (ORNL-3397(p.112-13))
LITHIUM BROMIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
LITHIUM CARBONATES
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
LITHIUM CHLORIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
LiCl–KCl, preparation of eutectic, 17: 15859(R) (ORNL-3397(p.112-13))
LITHIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
LITHIUM FLUORIDES
color centers of irradiated, effects of magnesium on optical absorption of, 17: 15960 (TID-18146)
radiation effects of neutrons on, nuclear magnetic resonance studies of, 17: 16111
LITHIUM HYDRIDES
development as reactor moderator material, 17: 17445
LITHIUM IODIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
LITHIUM IONS
energy levels of negative, quasi-discrete, 17: 16835
ionization by electron beams, measuring cross section for, 17: 16792(R) (TID-18258)
ionization energy of transition level $1s2s\,^3S$, 17: 16807
LITHIUM ISOTOPES
separation by flame spraying of salt solution, 17: 16499(P)
LITHIUM ISOTOPES Li-6
nuclear density distribution of, shell models for, 17: 17176
reactions with lithium-7 at 2 Mev, alpha spectra for, 17: 17197
LITHIUM ISOTOPES Li-7
deuteron reactions with, alpha spectra from, 17: 17223
deuteron reactions(d,n), neutron polarization from, 17: 17125 (TID-18137)
deuteron reactions (d,n) with, neutron polarization in, 17: 17087
neutron elastic scattering by, 17: 17094 (TID-18277)
proton reactions(p,n), neutron polarization from, 17: 17125 (TID-18137)
proton reactions (p,n) on, polarization distributions from, 17: 17167
proton reactions with, cross sections for neutron production in, 17: 17220
reactions with lithium-6 at 2 Mev, alpha spectra for, 17: 17197
use in resin in PWR cooling system for reduction of tritium in coolant, 17: 17572 (WAPD-PWR-TE-103)
LITHIUM ISOTOPES Li-9
hyperon(Λ^0) binding energy in hypernucleus of, 17: 17175
LITHIUM URANATES
structural properties for uranyl bonding, 17: 15959 (TID-18140)
LITTER SIZES
radiation effects in mice, 17: 15629 (LADC-5278)
LIVER
function tests, using gold-198 and iodine-131 simultaneously, 17: 15611
gold-198 distribution in, after intracardiac injections in rats, 17: 15607
immunologically reactive cells in, development, 17: 15644 (USNRDL-TR-605)
radiation effects of 30-Mev electrons, 17: 15648
radiation effects on synthesis of ascorbic acid in rat, 17: 15656
radiation effects on free radicals in lipid fraction, 17: 15672
radiation effects on regenerating rat, 30-Mev electron, 17: 15677
radiation effects on tissue homogenates of, 17: 15736
radiation effects on protein metabolism by, x, 17: 15750
radiation effects on composition of proteins in, 17: 15770
radiation effects on protein metabolism in, 17: 15781
radiation effects on enzymatic activity of regenerating, 17: 15785
radiation effects on ribonucleic acid metabolism in, 17: 15798
radiation effects on morphology of, in mice, 17: 15817(T)
radioactive contamination of human, from fallout, 17: 16346
radioinduced tumors, acceleration by injection of carbon tetrachloride in mice, 17: 15643 (USNRDL-TR-596)
thorium(IV) oxide effects on, case study of late, 17: 15691
transplantation of, effects of, on leukemia in irradiated mice, 17: 15724
LIVER DISEASES
radiodiagnosis, 17: 15543 (UCLA-511)
LIVERMORE POOL TYPE REACTOR
off-gas cleaning equipment performance, 17: 16332(R) (UCRL-7143)
LOS ALAMOS MOLTEN PLUTONIUM REACTOR EXPERIMENTS
design and operation of LAMPRE I, 17: 17596(R) (LA-2833)
LUBRICANTS
bibliography on high-temperature, 17: 16169 (AD-282462)
preparation of radiation-resistant, 17: 15866(P)
preparation of radiation-resistant, 17: 16764(P)
radiation effects, 17: 16102
radiation effects, 17: 16724
LUMINESCENT MATERIALS
safety hazards of radioactive, 17: 16338
LUNGS
radioactive contamination of human, from fallout, 17: 16346
radiotherapy of carcinomas of dog, effects of direct, 17: 15830
LUTETIUM
content of, in marine organisms, 17: 15604
neutron capture in, gamma energies from thermal, 17: 17181
LUTETIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
LUTETIUM ISOTOPES Lu-176
gamma emission, 17: 17181
LUTETIUM ISOTOPES Lu-177
effects of, on HeLa cells in tissue cultures, 17: 15707
gamma spectra, 17: 17165
LYMPH CELLS
radiation effects, pyknosis in thymocytes, 17: 15667
radiation effects on ribonuclease activity in lymph cells, 17: 15690
radiation effects on metabolism, 17: 15833
LYMPH SYSTEM
effects on radiation resistance of animals, 17: 15754

histology, effects of extracorporeal irradiation of blood, 17: 15639(R) (TID-18194)
radiation damage of spleen lymphoid centers, effects of thymus on recovery from, 17: 15752

M

MAGNESIUM
analysis for boron, absorptiometric method for, 17: 15881 (PG-Report-409)
determination by x-ray spectrometry using electron-beam excitation, 17: 15908
determination in neptunium by ion exchange and spectrography, 17: 15896
determination in ocean-bottom cores by activation analysis, 17: 15886 (TID-18125)
effects on optical absorption of color centers of lithium fluoride, 17: 15960 (TID-18146)
light emission from, at 50°C in 0.25 to 27 μ wavelength region, 17: 15953 (NASA-TN-D-1523)
luminescent effects of, on uranium, 17: 15928
neutron elastic scattering and polarization by, at 2.8 Mev, 17: 17294
photon elastic scattering at particle threshold energy, cross sections for, 17: 17153
reduction of zirconium tetrachloride using, preparation of zirconium by, 17: 16615
spectra of, spin-orbit coupling in band structure, 17: 16845
MAGNESIUM ALLOYS
analysis for thorium and zirconium using xylenol orange, 17: 15921
ignition and corrosion of, at high temperatures, 17: 16598
Al–Cu–Mn, neutron diffraction study of κ magnetic phase of, 17: 16702
Mg–Mn–Zr, design for fuel element canning, 17: 16730(P)
Mg–Pu, preparation, 17: 16568
MAGNESIUM BROMIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
MAGNESIUM CHLORIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
MAGNESIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
MAGNESIUM FLUORIDES
heats of ionization and sublimation and polymerization for, 17: 16770(R) (ANL-6666)
MAGNESIUM IODIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
MAGNESIUM ISOTOPES Mg-24
bremsstrahlung reactions (γ,p) at 24 Mev, cross sections for, 17: 17155
Coulomb excitation of, reorientation effects in, 17: 17140
deuteron reactions (d,p) on, knock-out mechanism in, 17: 17168
gamma reactions (γ,p), proton energy distribution from, 17: 17152
interactions with alpha particles (α,γ) dependence upon resonance levels, 17: 16916
neutron inelastic scattering by nonspherical, 17: 17248
proton elastic scattering cross sections, 17: 17261
MAGNESIUM ISOTOPES Mg-25
energy levels from (n,α) reactions on silicon-28 at 13.4 and 13.8 Mev, 17: 17145
gamma reactions (γ,p), proton energy distribution from, 17: 17152
MAGNESIUM ISOTOPES Mg-26
energy levels from (n,α) reactions on silicon-29 at 13.4 and 13.8 Mev, 17: 17145
gamma reactions (γ,p), proton energy distribution from, 17: 17152
MAGNESIUM MANGANESE FERRATES
magnetic properties of, effects of rare earth oxides on, 17: 16019
MAGNESIUM NITRATES
reactions of, with dinitrogen tetroxide and spectra of anhydrous, 17: 15995
MAGNESIUM OXIDES
preparation of pure, 17: 15859(R) (ORNL-3397(p.112-13))
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
thermal expansion, x-ray studies, 17: 16668
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
$MgO–ZrO_2$, phase boundaries of cubic solid solutions of, 17: 15974
$MgO–ZrO_2$, phase boundaries of cubic solid solutions at 1400 to 2285°C, 17: 15975
MAGNESIUM SULFATES
dehydration of monohydrate to anhydrate of, bisulfate formation in, infrared studies of, 17: 16028
reactions with cristobalite, 17: 15986
MAGNET COILS
development of superconductor, at ORNL, 17: 17336(R) (ORNL-3392 (p.66-85))
flux accumulation in superconducting, development of pumping method for, 17: 16174 (LADC-5418)
MAGNETIC FIELDS
calibration and measurement, 17: 16790 (TID-18216)
charged particle focusing in cylindrically symmetric r^{-n}, 17: 16387
effects on light propagation, 17: 16974
electric discharge in, helical instability in positive-column, 17: 17352
interactions of transverse, with fluid in couette flow, 17: 17339 (R63SD16)
interactions with free-surface waves on liquid metals, 17: 16784 (NASA-TR-R-161)
modulation of spinning search coil signal by time-variant, 17: 16389
penetration of, into superconducting sphere, transient effects of, 17: 16816
plasma acceleration by travelling, 17: 16771(R) (ASD-TDR-62-1105)
plasma behavior, 17: 17360
plasma containment by, apparatus for, 17: 17390(P)
plasma instability in crossed electric and, 17: 17356
plasma pinch stability in, 17: 17376
production of r^{-n}, 17: 16387
turbulent flow of mercury in transverse, skin friction coefficients for, 17: 16229 (NP-12631)
MAGNETIC MIRROR MACHINES
plasma production in, high-density proton, 17: 17338(R) (ORNL-3392 (p.89-93))
spark gap design for, 50 to 80 kv, 17: 17387
MAGNETIC MIRRORS
plasma production in, physics of, 17: 17332(R) (ORNL-3392(p.28-46))
MAGNETIC MONOPOLES
existence of, forbidden by parity conservation, 17: 17399
MAGNETIC RESONANCE
properties of magnetoplasma, in metals, 17: 16841
relaxation of spin-lattice in paramagnetic salts, 17: 16839
use of electron spin, in biological studies, 17: 15547
MAGNETIC SUSCEPTIBILITY
measurement device for, design and construction of, 17: 16380 (AERE-R-4186)
MAGNETOHYDRODYNAMIC CELLS
use of nonthermal ionization in, 17: 16188
MAGNETOHYDRODYNAMICS
book: *Wave and Oscillation Effects in Super-High Frequency Electron Fluxes*, 17: 17388
convection from vertical plates, analysis, 17: 16247
couette flow behavior with oscillating transverse magnetic field, 17: 17339 (R63SD16)
drag and search coil response in moving magnetized plasma, 17: 17345
equations of, 17: 16788 (RS8AGT967)
flow over wedge, hypersonic, 17: 16855
fluid flow in, nonisentropic perturbations of, 17: 16510
magnetic field interactions with surface waves, 17: 16784 (NASA-TR-R-161)
plasma characteristics in, virial theorem for, 17: 17372
skin friction in turbulent channel flow, 17: 16229 (NP-12631)
MAGNETOMETERS
design of helium, for space uses, 17: 16874
performance of spinning search coil, 17: 16389
MAGNETS
current stabilization of a-c electro-, with nonlinear impedance, 17: 16202(P)
demagnetizing ferro-, design of device for, 17: 16402(P)

design and testing of, for Stanford linear accelerator, 17: 17317(R) (SLAC-8)
design for variable-length focusing, 17: 17310 (BNL-6844)
MAIZE
radioinduced in maize, 17: 15626 (BNL-6027)
radiosensitivity of chromosomes in seed during germination, 17: 15650
radiosterilization of sweet corn, effects on flavor and storage time, 17: 15675
strontium uptake by roots, 17: 15610
MAMMALS
radiation sensitivity of, effects of chemicals on, 17: 15753
MAN
cesium, potassium, and rubidium content in bone, muscles, and soft tissues in, 17: 15603
cesium-137 content in urine from, estimation of body burden from, 17: 16343
cesium-137 uptake by, under natural conditions, 17: 16304
pathological effects of radium dial paints on, epidemiological follow-up of, 17: 16342
radiation effects, review, 17: 15634 (TID-15964)
radiation effects on developing nervous system, 17: 15638 (TID-18139)
radiation effects on mutations and somatic anomalies in, relation of dose to, 17: 15665
radiation effects on leukemia incidence in, 17: 15834
radiation exposure of, protective measures against, 17: 16348
radiation tolerance dose to ovaries in, 17: 15594
radioactive contamination of organs in, from fallout, 17: 16346
radioinduced leukopenia in, prognostic significance, 17: 15819
radioiodine uptake in infants, 17: 15600
MANGANESE
alloying effects on titanium, 17: 16580(P)
determination in neptunium by ion exchange and spectrography, 17: 15896
determination of, in ores, x-ray spectrum, 17: 15900
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
isotopic exchange in soils, 17: 15581
luminescent effects of, on uranium, 17: 15928
neutron capture gamma spectra, 17: 17255
separation of, from indium and gallium using cinnamic acid, 17: 15924
MANGANESE ALLOYS
Fe–Mn, electronic specific heat, 17: 16698
Mg–Mn–Zr, design for fuel element canning, 17: 16730(P)
Mn–Ni, electronic specific heat, 17: 16698
Mn–Pu, phase diagram, 17: 16567
MANGANESE COMPLEXES
with *N*-(2-pyridylmethyl) iminodiacetic acid, stability of, 17: 15993
MANGANESE FERRITES
magnetic properties of, effects of rare earth oxides on, 17: 16019
MANGANESE OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
MARITIME REACTORS
concepts for British nuclear ship, 17: 17581
containment and restraint devices for, design, 17: 17487(P)
development in Great Britain, review, 17: 17580
dynamics of boiling, effects of ship motion, 17: 17578
MASERS
design of nuclear magnetic, for frequencies below 50 Mc, 17: 16908(P)
design with superconductive magnetic field, 17: 16909(P)
MASS SPECTROMETERS
design, characteristics, and performance of, constructed at the Laboratoire de Géologie et Géochimie Nucléaires, 17: 16385 (NP-12457)
design of oscillating-ion type, for gas analysis in vacuum, 17: 15935(P)
MASS TRANSFER
in stirred vessel extractor, hydrodynamic model, 17: 16241
MATERIALS TESTING
determination of radiation effects on metals and alloys at, 17: 16742(R) (NP-12628)
facilities for pressure-tube, 17: 16740 (HW-76158)
methods for reactor components, nondestructive, 17: 17448
MATHEMATICS
coding objects for self-organization, feasibility of, 17: 16506 (SCTM-251-62(24))
crossing symmetry in S-matrix theory, 17: 17034
derivation of asymptotic expansions of exponential integrals with applications to Coulomb excitation functions, 17: 17133
dielectric formulation of many-body problems, 17: 17075
expressions for 3-j symbols, 17: 16957 (ORNL-TM-514)
field equations for gravitational energy radiation, 17: 16832
generalized path variable method, Boltzmann equations in, 17: 16511
irreducible representation in a direct product of irreducible representations of SU(3), multiplicity of, 17: 16512
iterative methods for unfolding radiation detector data, 17: 16429 (TID-18304)
non-Abelian gauge fields and Lorentz gauge formulation, 17: 16513
random-walk solutions of partial difference equations for lattices, 17: 16509
recurrence relations for Appell functions in, calculation of matrix elements in angular momentum representation, 17: 16962
roots of n-degree polynomials, IBM-610 program for calculating, 17: 16425 (ISS-62/11)
solution of inhomogeneous linear equations for the odd order spherical harmonics approximation of neutron transport, 17: 17089 (CRT-1088)
solution of linear differential equations for determining restrained bowing of fuel pins, 17: 16661 (TRG-Report-441)
solution of oscillating magnetohydrodynamic couette flow, 17: 17339 (R63SD16)
solutions to Dirac equation with Yukawa potential, 17: 16990
MATTER
dielectric susceptibility of, in states with population inversion, 17: 17374
electromagnetic-signal propagation through, distortion effects, 17: 16890
interactions with radiation, elementary processes in, 17: 17156
quantum statistics of, containing negative-energy particles, 17: 16998
radiation effects on, theory, 17: 16883
MECHANICAL DRIVES
design for reactor cooling system pumps, 17: 17414 (HW-SA-2922)
MECHANICS
collision lifetimes in many-body processes, 17: 17030
construction of invariant scattering amplitudes for arbitrary spin and analytic continuation in total angular momentum, 17: 17035
interaction matrix element in a shell model, 17: 17217
particle dynamics in a bounded plasma, 17: 17366
plasmoid existence in relativistic systems, denial of, 17: 16829
principles of classical dynamics, 17: 16786 (NYO-10250)
stability of an infinite system of mass points interacting under a Newtonian force, 17: 16831
transport phenomena in gases at moderate densities, statistical, 17: 16822
uniformity accelerated motion and relativity, transformations for, 17: 16798
MEMBRANES
radiation effects on muscle, 17: 15642(R) (TID-18268)
radiation effects on sodium and potassium effluxes in muscle cells, 17: 15641 (TID-18221)
MEMORY DEVICES
use of ferrite, with spark chambers, 17: 16427 (PPAD-461E)
MENDELEVIUM
properties and chemical separation methods of, 17: 15972
MERCAPTO GROUP
radiosensitivity effects in mice, 17: 15842
MERCHANT VESSELS
description of first German nuclear-powered, 17: 17579
MERCURY
determination by atomic absorption spectroscopy, 17: 15857(R) (ORNL-3397(p.57-70))
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
effects on mechanical properties of zinc crystals in presence of radiation, 17: 16749
effects on radioinduced deformation of zinc single crystals, 17: 16676
flow in transverse magnetic field, skin friction coefficients for turbulent,

17: 16229 (NP-12631)
heat transfer to, in in-line flow through bundle of circular rods, 17: 16222 (BNL-6826)
interactions of one-dimensional waves in, with transverse magnetic field, 17: 16784 (NASA-TR-R-161)
magnetoplasma resonance in, 17: 16841
neutron-shielding performance of, 17: 16731(P)
sorption of, by lithium chloride cation exchange resin, 17: 15992
MERCURY ALLOYS
solvent properties of, for samarium and ytterbium, 17: 16157
MERCURY COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
MERCURY, DIPHENYL-
radiolysis, 17: 16062
MERCURY ELECTRODES
uses in polarographic studies of aquocupric complex in hydrofluoric acid, 17: 15961 (TID-18198)
MERCURY ISOTOPES Hg^{-197}
gamma spectra, 17: 17165
MERCURY ISOTOPES Hg^{-203}
gamma spectra, 17: 16438
MERCURY OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
MESONS
interactions with nucleons, physical diagrams for vertex portions of, 17: 16966
interactions with baryons and mesons, Regge asymptotic amplitudes for, 17: 17046
interactions with nucleons, Regge trajectories in, 17: 16770(R) (ANL-6666)
photoproduction of man 279.2 Mev, on protons, 17: 16947 (ISS-62/24)
properties of vector, as Regge poles, 17: 17045
MESONS (η)
decay modes of, 3π, 17: 17027
decay of, radiative, 17: 17119 (JINR-P-1164)
decay of, two-gamma, 17: 17192
quantum numbers for, 0^-+ assignment to, 17: 16994
MESONS (η')
interactions with mesons (K), effects on $K_{\mu 3}$ decays, 17: 16996
lifetime calculations, 17: 17184
photoproduction from hydrogen, kinematics for 725 to 1500-Mev, 17: 16946 (ISS-62/15)
MESONS (P)
existence in $\pi^- + p$ reaction at 6.1 Bev/c, 17: 16965
MESONS (K)
interactions with protons, cross sections and polarizations for, 17: 17003
interactions with nucleons, angular distribution of particles produced near threshold in, 17: 17098
production by antinucleon annihilation in meson (π)-nucleon and nucleon-nucleon collisions, 17: 16953 (JINR-P-1163)
spin of K*, determination by (K,K*) pair production, 17: 17055
MESONS (K^-)
decay modes of, 3π, 17: 17027
interactions with protons, hyperon (Y_1^*) spin from, 17: 17039
interactions with protons, 1.66-Bev Y_1^* from, 17: 17041
interactions with protons at 620 to 850 Mev/c, resonances in, 17: 17042
reactions in deuterium, branching ratio ($\Lambda\pi^-p/\Sigma^0\pi^-p$) for, 17: 16981
reactions with emulsion nuclei at 1.3 and 1.5 Bev/c, production of hyperfragments from, 17: 17191
MESONS (K^+)
decay modes of, 3π, 17: 17027
interactions with protons at 970, 1170, and 1970 Mev/c, elastic, 17: 17015
MESONS ($K_{\mu 3}$)
decay, model for violation of $|\Delta I| = \frac{1}{2}$ rule in, 17: 16996
MESONS ($K^0_{\mu 3}$)
decay of, study of low energy (π-π) interaction by, 17: 17007
MESONS ($K^+_{\mu 3}$)
decay of, study of low energy (π-π) interaction by, 17: 17007
MESONS (μ)
angular distribution in meson (π) decay, 17: 17019
capture by complex nuclei, hyperfine effects in, 17: 17229
decay modes of, neutrinoless, 17: 17026
decay of bound, in titanium, iron, and lead, 17: 17297
scattering by iron, 17: 17228
MESONS (μ^-)
captured of partially polarized, angular distribution and polarization of recoil nuclei in, 17: 17117 (JINR-P-1160)
interactions of 8-Bev polarized, with electrons in magnetized iron, 17: 17017
reactions with helium-3, calculation of rates of, 17: 17049
reactions with helium-3 (μ,ν), measurements of rate, 17: 17278
MESONS (μ^+)
decay of, electron spectrum from, 17: 16991
MESONS (π)
angular correlations for, in antihyperon and hyperon decays, 17: 16984
decay of, meson (μ) angular distribution in, 17: 17019
energy distribution from nucleon-nucleon interactions at 100 Bev, 17: 16971
interactions, low-energy length of, 17: 17059
interactions of, theory for resonances in, 17: 17037
interactions with nucleons, calculation of, 17: 17123(R) (TID-18127)
interactions with mesons (π), resonance, 17: 16948 (JINR-D-1128)
interactions with mesons (π) at high energies, cross sections for elastic, 17: 16951 (JINR-P-1150)
interactions with nucleons, hyperon and meson (K) production in, 17: 16953 (JINR-P-1163)
interactions with nucleons, analyticity and unitarity conditions in, 17: 16955 (NYO-10238)
interactions with mesons (π), amplitudes of, 17: 16966
interactions with mesons (π), review of theory, 17: 16979
interactions with nucleons, chirality and structure of, 17: 16989
interactions with hyperons, hyperons (Y*) from, 17: 16995
interactions with protons, cross sections and polarizations for, 17: 17003
interactions with hyperons, coupling constants for, 17: 17025
interactions with nucleons, Regge-pole analysis of, 17: 17038
interactions with hyperons (Λ^0), hyperon (Y_1^0) spin from, 17: 17039
interactions with hyperons (Λ) parity and spin of Y_1^0 from, 17: 17040
interactions with hyperons (Λ), 1.66-Bev Y_1^0 from, 17: 17041
interactions with hyperons (Λ), theory for hyperons (Y_1^0) from, 17: 17043
interactions with nucleons, angular distribution of particles produced near threshold in, 17: 17098
photoproduction from nucleons, amplitude for low-energy, 17: 17274
photoproduction on nuclei, analysis by N/D method, 17: 17163
production in particle decay, forbidden multi-, 17: 16952 (JINR-P-1161)
production of double-charged, in (π^-,p) collisions at 900 Mev, 17: 17028
MESONS (π^-)
absorption and moderation in hydrogen (liquid), 17: 17230
absorption and scattering in nuclear emulsion, at 5.7 Bev/c, small angle, 17: 16980
absorption by complex nuclei, 17: 17108 (ISS-62/21)
capture by light nuclei, formation of protons, deuterons, and tritons from, 17: 17273
interactions with nucleons, mechanisms for gamma production in inelastic, 17: 17192
interactions with protons at 6.1 Bev/c, existence of f° particle in, 17: 16965
interactions with protons at 900 Mev, production of double-charged mesons (π) in, 17: 17028
interactions with neutrons, three-pion resonances obtained from, 17: 17050
reactions with carbon and nitrogen at 7 Bev, meson (η) radiative decay in, 17: 17119 (JINR-P-1164)
scattering of, on protons at 300 Mev to 9 Bev, calculation of propagation of forbidden collisions in, 17: 16969
MESONS (π^+)
photoproduction from hydrogen near threshold, 17: 17082
photoproduction on deuterons, coherent, 17: 17020
MESONS (π^0)
angular distributions from gamma reactions with hydrogen at 187 Mev, 17: 16985

decay of, to $e + \nu + \gamma$, 17: 17048
emission in $_{A}He^{*}$ decay, 17: 17190
photoproduction from hydrogen near threshold, 17: 17084
slowing down of, by electrons in dense plasma and metal, 17: 17268

MESONS (ζ^{*})
photoproduction on protons, 17: 16987

METABOLISM
radiation effects in liver mitochondria, whole-body exposure, 17: 15570
rate of, role in radioprotective action, 17: 15794

METAL COMPLEXES
with oxy acids, chemical technology of, 17: 15918

METAL-FOIL DETECTORS
neutron resonance integrals and self-shielding factors for, 17: 17106 (DP-817)

METALLURGY
research programs progress on, 17: 16527(R) (USBM-U-1001)
research progress at Hanford, Oct. to Dec. 1962, 17: 16741(R) (HW-76228)

METALS
analysis for oxide in liquid, apparatus for, 17: 16409(P)
analysis of, for heat of combustion and oxide composition in burning, methods for, 17: 15933
analysis of, for impurities, ignition techniques for, 17: 15933
bibliography on defense, 17: 16523 (NP-12632)
bibliography on technology of liquid, Sept. 1962 to Feb. 1963, 17: 16519 (LM-TAB-21)
book: *Problems in Metal Physics and Metallography*, 17: 16540
book: *The Influence of Temperature on the Mechanical Properties of Metals and Alloys*, 17: 16725
defects, effects of size and chemical interactions, 17: 16694
electrical resistivity, residual due to defect pairs, 17: 16695
mechanical properties at different temperatures, book, 17: 16725
photoelectron emission by, theory of, 17: 16797(T) (UCRL-Trans-907(L))
sputtering by ion beams, breakdown as function of angle of incidence in, 17: 16818
superconductivity in, theory of, 17: 17076
technology of liquid, review, 17: 16535
thermal properties of, quantum field theory for, 17: 16806

METEOROLOGY
data for Oak Ridge, 10-year history, 17: 16264 (ORO-199)

METHACRYLIC ACID, BUTYL ESTER POLYMERS
radiolysis of isomeric, production of free radicals in, 17: 16070

METHACRYLIC ACID, ESTERS
cetyl-, polymerization of, 17: 16059

METHACRYLIC ACID, METHYL ESTER POLYMERS
luminescent properties of ultra violet absorbing and transmitting, 17: 16418 (BNL-6865)
radioinduced defects in, electron spin resonance studies of decay, 17: 16060

METHANE
Ar–CH_4, ionization by alpha particles, slow component in, 17: 16849

METHANOL
effects on radioinduced graft polymerization, 17: 16041(R) (NCSC-2477-10)

METHIONINE
effects of methionine sulfoximine on distribution of potassium in rat tissues, tracer study, 17: 15687
effects on hemorrhage in rats, 17: 16364(R) (NP-12602)
metabolism of sulfur-35 labeled, by irradiated rabbit bone marrow and spleen, 17: 15843
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668

METHYLAMINE
dissociation constant of alpha-deuterated-, potentiometric and spectrophotometric determination of, 17: 15990
radiolysis products of, 17: 16043(R) (TID-18094)

METHYLENE BLUE
sorption of, particle size determination using, 17: 15938 (AEET/CD/5)

MICA
sputtering of, by krypton ions at 4 to 30 kev, cathode coefficient for, 17: 16817

MICE
carcinogenic effects of soft x rays on, 17: 15823
immunological reactions to skin homografts, 17: 15758
immunological tolerance in radiation chimeras, 17: 15759
iodine metabolism, tracer study, 17: 15588 (LADC-5209)
radiation effects on breeding characteristics, 17: 15629 (LADC-5278)
radiation effects on *Trichinella spiralis*, immunity in, 17: 15654
radiation effects on toxicity of plant substances on, 17: 15678
radiation effects of chronic, low-dose gamma exposure, 17: 15686
radiation effects on desoxyribonucleoprotein in spleen in, 17: 15706
radiation effects on glomerulus and proximal tubule of kidneys in, 17: 15712
radiation effects on incidence and latent period of leukemia in, 17: 15724
radiation effects on stem cell compartment in, *in vivo*, 17: 15725
radiation effects on aging in, 17: 15726
radiation effects on intestinal epithelium in, 17: 15746
radiation effects on tolerance to skin grafts, 17: 15760
radiation effects on 5-hydroxytryptamine content in small intestine in, 17: 15705
radiation effects on cytoplasm of distal tubule cells of kidneys in, 17: 15713
radiation effects on liver in, protective effects of 2-methylpiperazine dithioformate against, 17: 15809
radiation effects on, protective effects of spleen cell injection or splenectomy on, 17: 15811
radiation effects on, protective effects of dialized and whole spleen homogenates against lethal, 17: 15812
radiation effects on, effects of lipoxidase and olive oil on, 17: 15813
radiation effects on oocyte maturation in ovaries in, 17: 15816(T)
radiation effects on morphology of liver in, 17: 15817(T)
radiation effects on hair growth on, effects of cortisone on, 17: 15822
radiation effects on, protective effects of chemicals against, 17: 15826
radiation injuries, correlation of systemic and hematological recovery, 17: 15804 (USNRDL-TR-606)
radiation sickness of, effects of appendectomies, chemicals, and splenectomies on resistance to, 17: 15754
radiation sickness prophylaxis and therapy in, 17: 15841
radiation sickness of, biometrical studies of, 17: 15846
radiosensitivity of spermatogenesis, 17: 15637(R) (TID-18135)
response to antigens, suppression by anti-tumor agents, 17: 15584
selection for radiation resistance, 17: 15680
skin grafts, genetic factors affecting take, 17: 15585

MICROORGANISMS
radiosensitivity of food-spoilage, 17: 16374

MICROWAVE EQUIPMENT
design and testing, 17: 17317(R) (SLAC-8)
research on klystrons, 17: 17317(R) (SLAC-8)
wave propagation in, 17: 17388

MICROWAVES
reactions with plasma, 17: 17371

MILK
contamination from fallout, health implications of, 17: 15619
contamination of, by iodine-131, effects on iodine uptake by thyroid gland of, 17: 15605

MINERALS
analysis by x-ray fluorescent spectrometry, multielement calibration in, 17: 15893
rare earth distribution, 17: 16278

MITOCHONDRIA
radiation effects on oxidative phosphorylation in liver, whole-body exposure, 17: 15570

MITOSIS
radiation effects on, in rat skin, 17: 15694
radiation effects on, in crystalline lens in rabbits, 17: 15818(T)

MOLECULAR BEAMS
detection and measurement of, design of instrument using electron bombardment and mass filter for, 17: 16466
production in high vacua by jets, 17: 16796(T) (AEC-tr-5695)
research on heavy, in propulsion, 17: 16872

MOLECULES
reactions in planetary and stellar atmospheres, 17: 16886

MOLLUSKS

radiation effects on mussel gills, protective effects of benzimidazoles against ultraviolet, 17: 15674(T)
MOLYBDATES
reactions with cerium(III), electrometric studies, 17: 15997
MOLYBDENUM
alloying effects on titanium, 17: 16580(P)
arc initiation in toroidal hydrogen discharge, effects of impurity gases, 17: 16538
Auger spectrum, 17: 16810
casting, melting, and properties of, 17: 16532
cesium and rubidium ion scattering by, energies, 17: 17257
determination in uranium-molybdenum alloys, gravimetric, 17: 15882 (PG-Report-418)
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
determination of, radiation effects on spectrophotometric, 17: 15856(R) (ORNL-3397(p.54-6))
handbook, 17: 16549
neutron elastic scattering by, 17: 17094 (TID-18277)
noble-gas-ion reactions on, secondary electrons from, 17: 16836
properties for exothermic brazing, 17: 16608(R) (NP-12615)
radiation and temperature effects on mechanical and physical properties of, 17: 16760
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
MOLYBDENUM ALLOYS
corrosion of, by rubidium at 1000 to 2000°F, effects of titanium on, 17: 16634 (AGN-8063)
Al–Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Mo–Sn–Zr, properties as claddings for uranium carbide fuels, 17: 16650 (NAA-SR-7696)
Al–Mo–Ti, transformation behavior in, during cooling, 17: 16721
Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Mo–Nb, of niobium-93 Knight shift in, 17: 16709
Mo–Pu, phase diagram, 17: 16567
Mo–Pu–U, radiation effects on, 17: 16572
Mo–Re, superconductive properties and technical applications of, 17: 16705
Mo–Ti, thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
Mo–U, analysis for molybdenum, gravimetric, 17: 15882 (PG-Report-418)
Mo–U, formation of oriented oxide films on gamma-phase, 17: 16536
Mo–U, use as reactor fuels, burnup and cost studies for, 17: 16521 (NAA-SR-Memo-2974)
MOLYBDENUM CARBIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
$UMoC_2$, thermionic emission constants of, 17: 16783 (LADC-5128)
MOLYBDENUM CARBONYLS
proton magnetic resonances of, 17: 15962 (TID-18199)
MOLYBDENUM COMPACTS
Fe–Mo, fabrication, 17: 15532(R) (BMI-1607(Del.))
MOLYBDENUM ISOTOPES Mo-92
deuteron reactions (d,p) on, angular distribution of protons from, 17: 17258
MOLYBDENUM ISOTOPES Mo-93
spins and parities of ground and first excited states in, 17: 17258
MOLYBDENUM ISOTOPES Mo-94
deuteron reactions (d,p) on, angular distribution of protons from, 17: 17258
MOLYBDENUM ISOTOPES Mo-95
deuteron reactions (d,p) on, angular distribution of protons from, 17: 17258
spins and parities of ground and first excited states in, 17: 17258
MOLYBDENUM ISOTOPES Mo-96
deuteron reactions (d,p) on, angular distribution of protons from, 17: 17258
spins and parities of ground and first excited states in, 17: 17258
MOLYBDENUM ISOTOPES Mo-97
spins and parities of ground and first excited states in, 17: 17258
MOLYBDENUM ISOTOPES Mo-98
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
MOLYBDENUM ISOTOPES Mo-100
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
MOLYBDENUM OXIDES
MoO_3–NiO, radiation effects on catalytic activity in hydrodesulfurization of hydrocarbons, 17: 16117(P)
MOLYBDENUM SYSTEMS
Cr–Mo–Si, oxidation resistance properties as coatings for niobium alloys, 17: 16633(R) (AD-296341)
Mo–UO_2, properties at high temperatures, 17: 15532(R) (BMI-1607(Del.))
MONKEYS
fecal and urinary excretion of tritium-labeled normorphine by, 17: 15601
iodine metabolism, tracer study, 17: 15588 (LADC-5209)
radiation injuries, protection afforded by combined chemical prophylaxis and therapy, 17: 15633 (SAM-TDR-62-103)
radiation injuries, treatment with autologous bone marrow, 17: 15821
MOON
analysis of surface of, use of computers in remote, 17: 15888(R) (TID-18257)
analysis of surface of, instrumentation for radiometric, 17: 16894
influence on geomagnetic storms, 17: 16285
MORPHINES
preparation of tritium-labeled, 17: 15602
transformation of tritium-labeled, to normorphine, 17: 15602
MÖSSBAUER EFFECT
for impurity nucleus in a crystal, 17: 16868
pressure effects on, 17: 17130 (UCRL-10630)
spectra in crystals, two peaks of quadrupole splitting in, 17: 16013
use for detection of relativistic Doppler shift, 17: 17208
MUCOSA
sodium effect on electric potential in gastric, 17: 15645 (USNRDL-TR-608)
MUSCLES
cesium, potassium, and rubidium content in, in man, 17: 15603
radiation effects on cell membrane, 17: 15642(R) (TID-18268)
radiation effects from high-level exposure on morphology and metabolism, 17: 15641 (TID-18221)
MUTATIONS
radiation effects on *neurospora crassa*, visible and x-ray, 17: 15652
radiation effects on, in man, 17: 15665
radiation effects on, biophysics of, 17: 15701
radioinduced and spontaneous, in rhizobial plants, 17: 15649
radioinduced in Aspergillus, 17: 15679
radioinduced in coffee plants, 17: 15565
radioinduced in Drosophila, 17: 15681
radioinduced in maize, 17: 15626 (BNL-6027)
radioinduced in mice, 17: 15629 (LADC-5278)
radioinduced in plants, 17: 15541(R) (ORO-598)
radioinduced in plants, 17: 15563
radioinduced in rice, 17: 15564
radioinduced in rice, 17: 15566
radioinduced in spinach, 17: 15682
radioinduced in wheat, 17: 15731
MYOSINS
radiation effects on rabbit tropomyosin, gamma, 17: 16379

N

2,7-NAPHTHALENEDISULFONIC ACID, 4,5-DIHYDROXY-
chelates with uranium(VI), composition and stability, 17: 16073
1-NAPHTHOL, 2,4-DINITRO-
protective effects against radiation, metabolic factors in, 17: 15794
NATURAL WATERS
geochemistry around Umra uranium deposit, India, 17: 16303
NAVAL REACTORS
fuel element positioning and withdrawal in, design of equipment for, 17: 17521(P)
NEODYMIUM
content of, in marine organisms, 17: 15604
determination of, by radiometric titration using 8-hydroxyquinoline halogen derivatives, 17: 15925

determination of, in lanthanum oxide, spectrographic, 17: 15932
separation from lanthanum, 17: 16149(T) (CEA-tr-A-1230)
NEODYMIUM ALLOYS
Au–Nd, crystal structure, 17: 16658 (TID-18197)
NEODYMIUM CARBONATES
preparation by precipitation, 17: 15951 (LADC-5579)
thermal decomposition of, compound formations in, 17: 15951 (LADC-5579)
NEODYMIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
NEODYMIUM ISOTOPES Nd-141
isomeric transitions, 17: 17147
NEODYMIUM ISOTOPES Nd-144
energy level de-excitation characters for, experimental 1^-, 17: 17201
NEON
electric discharge in, behavior of, in area of sub-normal low pressure, 17: 16802
proton reactions on, ionization cross sections in, 17: 16886
thermal accommodation during adsorption of potassium and cesium on tungsten, 17: 16027
NEON IONS
reactions on metals, secondary electrons from, 17: 16836
NEON ISOTOPES Ne-20
alpha reactions (α,C^{12}), angular distribution in cluster model analysis of, 17: 17195
alpha reactions ($\alpha,\alpha'\gamma$), particle-gamma coincidence studies, 17: 17290
astrophysical application of the 7.20 (4+) Mev state of, 17: 16916
bremsstrahlung reactions (γ,p) at 24 Mev, cross sections for, 17: 17155
gamma reactions on, giant resonance in, 17: 17160
interactions with alpha particles (α,γ), dependence upon resonance levels, 17: 16916
production in supernova explosion, 17: 16916
NEON ISOTOPES Ne-22
internal conversion of 1.277-Mev transition in, 17: 17170
reactions with uranium-238, charge distribution curve and fission product yields for, 17: 17114 (JINR-P-1148)
NEPTUNIUM
analysis for impurities, by ion exchange and spectrography, 17: 15896
precipitation of, with thorium and uranium peroxides, 17: 16079
reduction of pentavalent, by iodide ion, kinetics of, 17: 16003
separation of, from hydrochloric acid by solvent extraction using tri-octylamine, 17: 16156
structure, 17: 16559
NEPTUNIUM CARBIDES
thermionic emission constants of, 17: 16783 (LADC-5128)
NEPTUNIUM COMPLEXES
preparation and properties of tetravalent, 17: 16075
NEPTUNIUM ISOTOPES Np-237
neutron fission lifetime, 17: 17299
NEPTUNIUM ISOTOPES Np-238
neutron fission lifetime of compound nuclei of, 17: 17299
NEPTUNIUM ISOTOPES Np-239
preparation, 17: 16551
NERVES
denervation of, effects on calcium metabolism in skeleton, 17: 15755
NERVOUS SYSTEM
radiation effects on developing, 17: 15638 (TID-18139)
radiation effects on protein metabolism in, 17: 15781
radiosensitivity of central, in rats, 17: 15744
radiosensitivity of embryonic rat, 17: 15745
NEUTRINOS
density of, in universe, experimental and theoretical data on, 17: 16910
interactions of, electromagnetic, 17: 17018
interactions with electrons, charge renormalization in elastic, 17: 16958 (UCRL-10336)
masses of electronic and muonic, 17: 16991
properties in space, 17: 16917
reactions with nuclei, 17: 17018
NEUTRON CROSS SECTIONS
radiative capture, near 30 and 65 kev, 17: 17222
NEUTRON DIFFRACTOMETERS
design, 17: 16469
specifications for, 17: 16467
NEUTRON PHOTOGRAPHY
equipment design for, 17: 16484(P)
NEUTRON SHIELDING
materials for, 17: 16731(P)
NEUTRON SOURCES
design for well logging, 17: 16415(P)
development, 17: 15858(R) (ORNL-3397(p.71-112))
theory and uses of, 17: 17102
use of, for humidity measurements at building sites, 17: 15903
NEUTRON SPECTRA
distribution in core and reflector of swimming-pool reactor, 17: 17600(T) (CEA-tr-A-1194)
equations for thermal, in reactors, 17: 17095
from deuteron breakup in deuteron bombardment of tritium and hydrogen at 5 to 12 Mev, 17: 17086
measurement, 17: 16438
NEUTRON SPECTROMETERS
performance, 17: 16353
steering and data registration for, design of mechanism for, 17: 16454
NEUTRONS
absorption and scattering, interference potential in resonance, 17: 17468
absorption cross sections in heterogeneous systems, resonance, 17: 17470
absorption in homogeneous media, mathematical analysis of resonance, 17: 17467
absorption of, mathematical analysis of resonance, 17: 17471
absorption of pile, effects on neutron activation analysis, 17: 15877 (MMPP-226-1)
angular distributions from (α,n) reactions with beryllium-9 and carbon 12, 17: 17154
capture by aluminum-27 at 14 Mev, gamma spectra from, 17: 17207
capture in annular traps, resonance, 17: 17469
capture in liquid organic halides, mechanisms for reactions following radiative, 17: 16076
capture of 30 to 65 kev, cross sections for radiative, 17: 17222
capture processes in element formation, role of neutron numbers 98, 108, and 116, 17: 17157
detection of, design of visual sensing device for radiography, 17: 16484(P)
distributions of, in EGCR, calculation of, 17: 17566 (TID-18245)
dosage determination, improvement by use of polyurethane attenuators, 17: 16332(R) (UCRL-7143)
dosimetry by nuclear emulsions, sources of error in, 17: 16434
dosimetry of, glass detector for, 17: 16474(P)
effects on matter, theory, 17: 16883
electric charge of, upper limits for, 17: 17012
energy spectra from proton reactions (p,n) with gold, nickel, rhodium, and tantalum, 17: 17293
evaporation from excited nuclei, distributions, 17: 17162
flux calculations for, two-group, 17: 17462
flux distribution in reactor cores, relations with power output, 17: 17410 (GEAP-3914)
flux measurement of, method and design of apparatus for, 17: 16477(P)
flux peaking at sharp corners, diffusion theory for, 17: 17092 (TID-16485)
interactions with protons at 23.1 Mev, polarization in, 17: 17024
monitoring, development of remote system for, 17: 16332(R) (UCRL-7143)
optical potential of, symmetry term in, 17: 17204
polarization and strength functions of, comparison in various models for, 17: 17101
polarization from (d,n) reactions with lithium-7, 17: 17087
polarization in deuteron reactions (d,n) with tritium at 16 and 24 Mev, 17: 17083
polarization in the carbon-12(d,n) nitrogen-13 reaction, 17: 17264
polarization of, from (d,n) reactions in nitrogen-14 at 1.32 Mev, 17: 17127 (TID-18256)
polarization of 2.8-Mev, in elastic scattering by nuclei, 17: 17294
probability distribution in multiplying assemblies, 17: 17091 (LADC-5383)
production by cosmic-proton reactions on space vehicles, 17: 16876
production in proton bombardment of lithium-7, cross sections for,

17: 17220
production in slab and spherical reactors, relation of critical size to, 17: 17425 (RM-3256-PR)
production of polarized, summary of reactions for, 17: 17125 (TID-18137)
reactions (n,α) with nickel-58, cross sections for, 17: 17139
reactions (n,α) with nuclei, statistical model calculations of cross sections for, 17: 17206
reactions (n,α) with carbon-12 at 14 Mev, mechanisms of, 17: 17288
reactions (n,αγ) and (n,pγ) with potassium-39, coincidence study of, 17: 17196
research with pulsed, 17: 17419(R) (MITNE-26)
resonances of "s," numerical analysis of time-of-flight experiments, 17: 17096
scattering by cadmium at 0.45 Mev, differential cross section, and polarization in, 17: 16770(R) (ANL-6666)
scattering by iron at 0.80 to 4 Mev, inelastic, 17: 17473
scattering by non-spherical nuclei, inelastic, 17: 17248
scattering by nonspherical nuclei, elastic, 17: 17246
scattering of polarized, at 0.1 to 25 Mev, 17: 17094 (TID-18277)
single-particle states of, energies of, 17: 17231
streaming from EGCR core, current estimates of, 17: 17548 (TID-18096)
transport cross sections for, optical model of, 17: 17472
transport in a slab, invariant imbedding approach to, 17: 17103
transport in cylindrical and spherical geometry, S_n solutions for, 17: 17463
transport in spherical geometry, one-group, 17: 17458
transport in spherical geometry, spherical harmonics approximation of, 17: 17459
transport of, in multilayer cylindrical geometry, spherical harmonics approximation of, 17: 17089 (CRT-1088)
transport of, in plane and spherical geometry, 17: 17456
transport of, spherical harmonics approximation for, 17: 17457
transport problems of, computer program for solution of, 17: 17093 (TID-18117)
transport theory, 17: 17455

NICKEL
alloying effects on titanium, 17: 16580(P)
argon-ion reactions on, secondary from, 17: 16836
determination in neptunium by ion exchange and spectrography, 17: 15896
determination of, in uranium fission products, 17: 15892
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
deuteron elastic scattering at 6.5 Mev, polarization, 17: 17263
ferromagnetic properties, 17: 16699
neutron capture gamma spectra, 17: 17255
neutron elastic scattering and polarization by, at 2.8 Mev, 17: 17294
oxidation of, nucleation-germination phenomena in, 17: 16596(T,R) (EURAEC-559)
proton reactions (p,n) at 5 to 12 Mev, neutron spectra from, 17: 17293
reactions with fluorine, mechanism of, 17: 15998
separation of, from indium and gallium using cinnamic acid, 17: 15924
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
triton ranges and stopping cross sections in, 17: 17212

NICKEL ALLOYS
electronic structure, 17: 16700
Al–Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Al–Cr–Fe–Ni–Ti, precipitation processes in, 17: 16718
Al–Cr–Fe–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Au–Ni, optical properties of films, 17: 16696
Ce–Ni, effect of annealing on coercive force of deformed, 17: 16716
Cr–Fe–Mo–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Cr–Fe–Ni, corrosion of, by steam at 1050°F, 17: 16587 (GEAP-4165)
Cr–Fe–Ni, tensile properties, 17: 16640 (DMIC-Memo-164)
Fe–Ni, electronic specific heat, 17: 16698
Fe–Ni, radioinduced order-disorder transitions, 17: 16701
Gd–Ni, effect of annealing on coercive force of deformed, 17: 16716
Mn–Ni, electronic specific heat, 17: 16698
Ni–Pr, effect of annealing on coercive force of deformed, 17: 16716
Ni–Pu, phase diagram, 17: 16567
Ni–V, electronic specific heat, 17: 16698

NICKEL ARSENIDES
effects on separation of uranium from ore concentrates by solvent extraction using TBP, 17: 16144 (NLCO-867)

NICKEL CARBIDES
NiC–TiC, emissivity of, measurements of, 17: 16787(R) (PWA-2163)

NICKEL CATALYSTS
radiation effects on hydrogenation of propene by, 17: 16084

NICKEL(II) COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993

NICKEL ISOTOPES Ni-58
deuteron reactions at 20 Mev, cross sections for, 17: 17216
neutron reactions (n,α), cross section for ground state transition, 17: 17139
proton elastic scattering at 7 to 12 Mev, cross sections for, 17: 16770(R) (ANL-6666)
reactions with oxygen-16, compound nucleus formation cross sections for, 17: 17118 (JINR-P-1162)

NICKEL ISOTOPES Ni-60
energy level lifetime in, 4_+, 17: 17219
proton elastic scattering at 7 to 12 Mev, cross sections for, 17: 16770(R) (ANL-6666)
proton inelastic scattering, gamma angular distribution from, 17: 17205
transition mixing ratios (E2/M1) for, measurement of $2^{+\prime} \rightarrow 2^+$, 17: 17205

NICKEL ISOTOPES Ni-64
proton scattering at 9.6 and 11.7 Mev, excitation levels determined by, 17: 17239

NICKEL ISOTOPES Ni-66
production in 80-Mev proton fission of terbium-159, absolute cross section for, 17: 16052(R) (TID-18261(p.44-8))

NICKEL OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
MoO_3–NiO, radiation effects of catalytic activity in hydrodesulfurization of hydrocarbons, 17: 16117(P)
NiO–WO_3, radiation effects on catalytic activity in hydrodesulfurization of hydrocarbons, 17: 16117(P)

NICOTINE
radiation effects on toxicity of, on mice, 17: 15678

NIOBIUM
alloying effects on titanium, 17: 16580(P)
analysis for tantalum, buffer effects in spectrochemical, 17: 15899
casting, melting, and properties of, 17: 16532
corrosion of, at high temperatures, electron microscopic determination of, 17: 16583(R) (EURAEC-545)
crystallization behavior, 17: 16653(R) (NP-12634)
determination in niobium oxide–tantalum oxide mixtures, spectrographic, 17: 15857(R) (ORNL-3397(p.57-70))
determination in tantalum, buffer effects in spectrochemical, 17: 15899
determination of, effects of phosphomolybdate on spectrographic, 17: 15930
determination of, in presence of tantalum and zirconium, using lumogallion, photometric, 17: 15929
determination of, in alloys, ores, and slags, x-ray spectrum, 17: 15900
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
determination of, luminescent, 17: 15928
mechanical properties of, effects of impurities on, 17: 16652(R) (NP-12633)
mechanical properties of, effects of hydrogen on, 17: 16728
oxidation of, kinetics of anodic, 17: 16675
oxidation resistance of, at high temperatures, 17: 16653(R) (NP-12634)
preparation of, by carbothermic reduction of pentoxide, 17: 16530(T) (JPRS-18277)
production by reduction of pentachloride using hydrogen, 17: 16548
production of, electrolytic, 17: 16547
properties and uses of, mechanical and physical, 17: 16715
properties for exothermic brazing, 17: 16608(R) (NP-12615)
proton reactions at 100 Mev, isomeric state from, 17: 17141
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
superconductive properties of, technical applications of, 17: 16705

NIOBIUM ALLOYS
corrosion of, in pressurized water reactors, 17: 16598
Al–Nb–Sn, crystal structure and alloying properties, 17: 16727

Be–Nb, development of, for high-temperature uses, 17: 16637(R) (BBC-115)
Be–Nb, oxidation of $NbBe_{12}$ and Nb_2Be_{17}, at 1200 to 1800°F, 17: 15947(R) (DRI-2088)
Cr–Nb–Ti, phase studies, 17: 16543
Hf–Nb–W, phase equilibria of niobium-rich regions, 17: 16641(R) (DRI-2091)
Mo–Nb, of niobium-93 Knight shift in, 17: 16709
Nb_3Sn, critical currents in, 17: 16805
Nb–Sn, crystal structure, equilibrium solubilities, and constitutional diagram for, 17: 16727
Nb–Sn, superconductive properties and technical applications of, 17: 16705
Nb–Ta–W, mechanical properties at 2600°F of coated, evaluation of, 17: 16633(R) (AD-296341)
Nb–Ti–Zr, fabrication of high-quality tubing of, 17: 16603 (ANL-FGF-409)
Nb–U, formation of oriented oxide films on gamma-phase, 17: 16536
Nb–U, phase transformation, effects of cooling rate on onset temperature for $\gamma \rightarrow \beta$, 17: 16672
Nb–W–Zr, phase equilibria of niobium-rich regions, 17: 16641(R) (DRI-2091)
Nb–Zr, corrosion of, in water at 680°F and steam at 750 and 900°F, 17: 16586 (GEAP-4098)
Nb–Zr, corrosion of, by rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
Nb–Zr, preparation of powders of, by igneous electrolysis, 17: 16529(T,R) (EURAEC-509)
Nb–Zr, properties as claddings for uranium carbide fuels, 17: 16650 (NAA-SR-7696)
Nb–Zr, properties of superconducting at 9,250 Mcps, 17: 16722
Nb–Zr, radiation effects, 17: 17447
Nb–Zr, superconductive properties and technical applications of, 17: 16705
Nb–Zr, thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
Sb–Nb–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)

NIOBIUM BORIDES
emissivity, measurement of spectral, 17: 16632(R) (AD-274654)

NIOBIUM CARBIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)

NIOBIUM CHLORIDES
reduction using hydrogen, 17: 16548

NIOBIUM CRYSTALS
tensile strength of single, effects of temperature on, 17: 16652(R) (NP-12633)

NIOBIUM ISOTOPES Nb-93
alpha reactions (α,xn) with, excitation functions, isomeric ratios, and product recoil ranges for, 17: 16047(R) (TID-18261(p.1-14))
magnetic resonance in molybdenum–niobium alloys, 17: 16709

NIOBIUM OXIDE FILMS
stresses in, measurements of, 17: 16685

NIOBIUM OXIDES
phase transformation, x-ray studies, 17: 16667
reduction of pentoxide by carbon at 1800°C, 17: 16530(T) (JPRS-18277)
NbO–TaO, analysis for niobium and tantalum, 17: 15857(R) (ORNL-3397(p.57-70))
Nb_2O_5–Ta_2O_5, chlorination in ore concentrates, 17: 16024
Nb_2O_5–Ta_2O_5, electrolytic reduction of, 17: 16547

NIOBIUM SYSTEMS
C–Hf–Nb–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–Nb–Ta–V–Zr, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–Nb–Zr–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
Fe–Nb–P, phase studies of, 17: 15971
Nb–Si–W, properties and structure of, 17: 16710
Nb–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)

NITRATE IONS
determination in plutonium and uranyl nitrates, volumetric, 17: 15875 (HW-76363)

NITRATES
properties of aqueous, from dissolution of clad fuel elements, 17: 16142 (IDO-14602)

NITRIC ACID
corrosive effects on construction materials for fuel processing plants, 17: 17451
determination in plutonium and uranyl nitrates, volumetric, 17: 15875 (HW-76363)
separation of uranium from, by solvent extraction using tridodecylamine, 17: 16155
HNO_3–NH_2SO_3H, solvent properties for plutonium, 17: 15957 (TID-16387)

NITRITES
formation of, by gamma radiolysis of nitrous oxide, 17: 16441

NITROGEN
additive effects on titanium, 17: 16580(P)
effects of heat transfer properties of terphenyl coolants, 17: 16228 (NAA-SR-Memo-8064)
electric discharge in, behavior of, in area of sub-normal low pressure, 17: 16802
electric discharge in, ionization processes in, 17: 16812
electric glow discharge in, electromagnetic waves from, 17: 16889
formation of, by gamma radiolysis of nitrous oxide, 17: 16441
helium-ion and proton reactions on, ionization cross sections in, 17: 16886
ionization by alpha particles, slow component in, 17: 16849
meson (π^-) reactions at 7 Bev, meson (η) radiative decay in, 17: 17119 (JINR-P-1164)
recombination coefficient of neutral atomic, 17: 16888
sticking factors for, on titanium film, 17: 17337(R) (ORNL-3392 (p.86-8))
triton ranges and stopping cross sections in, 17: 17212

NITROGEN ISOTOPES N-12
beta decay of, branching ratio and half life for, 17: 17236
beta decay of, branching ratio to 7.6 Mev level of carbon-12, 17: 17237
beta spectra of, test for conserved vector current theory with, 17: 17237

NITROGEN ISOTOPES N-13
formation in carbon-12(d,n) reaction, polarization of neutrons from, 17: 17264

NITROGEN ISOTOPES N-14
deuteron reactions(d,n), neutron polarization from, 17: 17125 (TID-18137)
deuteron reactions (d,n) at 1.32 Mev, polarization of neutrons from, 17: 17127 (TID-18256)
deuteron reactions (d,p) on, knock-out mechanism in, 17: 17168
fission of bismuth-209 and gold-197 by, 17: 17225

NITROGEN OXIDES
radiolysis of nitrous oxide, nitrite and nitrogen yields in, 17: 16441
reactions of tetravalent, with anhydrous barium, calcium, and strontium nitrates, 17: 15995

NITROGEN SYSTEMS
graphite-N, density of, design of measuring device for, 17: 16386(R) (TID-18162)

NITROSYL CHLORIDES
chlorine-36 exchange from, to metal chlorides, 17: 15996

NOBELIUM
synthesis of, 17: 16085

NORMORPHINE
fecal and urinary excretion of tritium-labeled, by dogs and monkeys, 17: 15601
preparation of tritium-labeled, 17: 15601
transformation of, from tritium-labeled morphine, 17: 15602

NORWAY
fallout content in milk during 1961, measurement of, 17: 15614 (A/AC.82/G/L.810)

NPD REACTOR
operation and startup of, 17: 17402 (AECL-1684)

NRX REACTOR
development and operation, review, 17: 17402 (AECL-1684)
fuel element preparation for, plutonium-containing, 17: 16570
fuel rod fabrication, review, 17: 16556
hazards of cobalt spill at, July 1958, 17: 17594 (IDI-158)

NUCLEAR BATTERIES
design of gas-filled thermionic, 17: 17586(P)

development of fission-electric cells, 17: 16189
performance in space propulsion systems, review, 17: 17611
NUCLEAR ELECTRIC MOMENTS
measurement, 17: 17306
NUCLEAR EMULSIONS
mesons (π), absorption and scattering at 5.7 Bev/c, small angle, 17: 16980
proton reactions on heavy nuclei in, at 24 Bev, 17: 17161
use in neutron personnel dosimetry, sources of error in, 17: 16434
NUCLEAR ENGINEERING
development, summary of EURATOM program for July to Sept. 1962, 17: 17441
summary of NORA Project from June to November 1962, 17: 17555(R) (TID-18108)
NUCLEAR MAGNETIC MOMENTS
measurement, 17: 17306
NUCLEAR MAGNETIC RESONANCE
determination in silicon by ultrasonics, 17: 16779 (ISS-62/17)
optical pumping cycle in, experimental verification of quantum theory of, 17: 17132
use in maser for frequencies below 50 Mc, 17: 16908(P)
NUCLEAR MODELS
accuracy of superfluid, for strongly deformed element properties using, 17: 17113 (JINR-E-1154)
book: *Physics of the Nucleus*, 17: 17280
collective potential-energy surface for quasi-spin, calculation of, 17: 17254
relation between shell and other, lecture on, 17: 17302
relation to shell model, lecture on, 17: 17305
vibration spectra of even-even spherical nuclei in, 17: 17137
NUCLEAR MODELS (COLLECTIVE)
gamma transitions in even nuclei in, 17: 17172
vibrational states of spherical nuclei in, 17: 17285
NUCLEAR MODELS (DROP)
equilibrium configuration and fission barrier for, at high angular momentum, 17: 17241
NUCLEAR MODELS (OPTICAL)
development and properties, 17: 17279
neutron transport cross sections in, 17: 17472
theory of, formal, 17: 17067
NUCLEAR MODELS (SHELL)
formulation of and connection with other nuclear models, lecture on, 17: 17302
formulation of and connections with other models, 17: 17305
interaction matrix elements in, 17: 17217
vibrational states of spherical nuclei in, 17: 17285
NUCLEAR PHYSICS
book: *Physics of the Nucleus*, 17: 17280
research in, 17: 17123(R) (TID-18127)
symmetry terms in optical potential, 17: 17204
NUCLEAR POWER PLANTS
design of nuclear-thermionic, 17: 17586(P)
structural elements for, review on, 17: 17583
thermodynamic cycle of reactor-magnetohydrodynamic generator, 17: 16188
NUCLEAR REACTIONS
analysis using nsec-pulsed accelerators, 17: 17282
angular correlation analysis of, coefficients for triple, 17: 17104 (CRP-615(Rev.))
book: *Nuclear Reactions. Volume II*, 17: 17281
cross sections for (n,α), statistical model calculations of, 17: 17206
cross sections for deuteron, activation, 17: 17216
cross sections for pair producing bremsstrahlung, 17: 17105 (DESY-A-2.96)
deuteron (d,n) and (d,p), knock-out mechanism in, 17: 17168
direct, dispersion method applied to, 17: 17304
direct, lecture on application of, 17: 17302
direct, theories and possible developments in, 17: 17303
evaporation of neutrons from, on excited nuclei, 17: 17162
photo-, giant resonance effects in, 17: 17284
photo-, on unfilled-shell nuclei, 17: 17160
products from, analysis of, in cyclotron chambers, 17: 17135
proton (p,n), direct mechanisms for, 17: 17226
statistical analysis, 17: 17471
NUCLEAR THEORY
book: *Physics of the Nucleus*, 17: 17280
collective properties of nuclei, lecture on aspects of, 17: 17308
effects of superconducting pairing relations in, 17: 17307
interactions in nuclear matter, velocity-dependent, 17: 17164
selected topics in, lectures on, 17: 17302
NUCLEI
beta decay near closed shells, pair-correlation effects on, 17: 17182
beta decay of, theory using exact electron wave functions, 17: 17177
beta decay systematics in heavy, 17: 17148
bremsstrahlung reactions with, cross sections for pair production in, 17: 17105 (DESY-A-2.96)
collective properties of, lecture on aspects of, 17: 17308
deformation alteration by rotation, 17: 17134
deuteron reactions with arbitrarily oriented, polarization in direct, 17: 17244
deuteron scattering by complex, 17: 17122 (PUC-1962-78)
deuteron splitting in field of deformed, 17: 17247
electromagnetic properties, 17: 17306
excitation by slow charged particles, cross section for, 17: 17267
fermion elastic scattering by, models for, 17: 17186
fission, theory for low-excitation energy, 17: 17283
formation of light, mechanism for, 17: 17149
gamma emission by aligned, correlation coefficients for double, 17: 17286
gamma reactions (γ,π^0) on Coulomb fields of, 17: 17184
gamma reactions on unfilled-shell, giant resonances in, 17: 17160
gamma reactions on, mesons (π) from, 17: 17163
gamma reactions on, giant resonance effects in, 17: 17284
gamma transitions in even, E2/M1 mixing ratios in, 17: 17172
inertia moments of, review of calculations of, 17: 17068
interactions in nuclear matter, velocity-dependent, 17: 17164
interparticle interactions in even-even, 17: 17214
ion elastic scattering by, quasi-classical analysis of heavy, 17: 17115 (JINR-P-1153)
magnetic parameters for deformed, with A = 153 to 187, 17: 17199
meson (K^-) reactions at 1.3 and 1.5 Bev, hyperfragment production in, 17: 17191
meson (μ) capture by complex, hyperfine effects in, 17: 17229
meson (π^-) capture by light, formation of protons, deuterons, and tritons from, 17: 17273
mesons (π^-) absorption by complex, 17: 17108 (ISS-62/21)
neutrino reactions, 17: 17018
neutron elastic scattering by, 17: 17094 (TID-18277)
neutron elastic scattering by nonspherical, 17: 17246
neutron evaporation from excited distributions, 17: 17162
neutron inelastic scattering on non-spherical, 17: 17248
neutron radiative capture cross sections for, 17: 17222
neutron reactions (n,α) with, statistical model calculation of cross sections for, 17: 17206
neutron single-particle states in, energies of, 17: 17231
nucleon level density in, p-shell, 17: 17070
packing of excitation levels near the thresholds of light, 17: 17099
periodic system of, 17: 17287
photoproduction of mesons (π) on, amplitude for low-energy, 17: 17274
polarization methods for, magnetic, 17: 17121 (LNF-62/102)
properties of, effects of superconducting pairing correlations on, 17: 17307
properties of strongly-deformed, accuracy of superfluid model for, 17: 17113 (JINR-E-1154)
proton reactions on, at 24 Bev in emulsion, 17: 17161
proton reactions (p,n) on even-even, for A = 40 to 82, 17: 17226
proton reactions (p,n), beta transitions in model for, 17: 17189
reactions of, effects of second-order isotope shift on, 17: 16803
spectra of spherical even-even, models for vibrational, 17: 17137
transitions in deformed odd and odd-odd, 17: 17146
vibrational states of spherical, models for, 17: 17285
NUCLEIC ACIDS
metabolism in irradiated rats, effects of injected native liver DNA on, 17: 15797

radiation effects on aqueous solutions of, 17: 15771
radiation effects on translocation in germinating barley, 17: 15775
radioinduced free radicals in, 17: 15767
synthesis of, effects of irradiated *S. typhimurium* on, 17: 15777
NUCLEONS
interactions in nuclear matter, velocity-dependent, 17: 17164
interactions in symmetric pseudoscalar fields, 17: 17047
interactions with nucleons and nuclei, investigation of, 17: 17123(R) (TID-18127)
interactions with mesons (π^-), mechanism for gamma production in inelastic, 17: 17192
interactions with nucleons, meson (π) resonance model of, 17: 16948 (JINR-D-1128)
interactions with mesons (π) and nucleons, production of hyperons and mesons (K) in, 17: 16953 (JINR-P-1163)
interactions with mesons (π) and nucleons, analyticity and unitarity conditions in, 17: 16955 (NYO-10238)
interactions with mesons, physical diagrams for vertex portions of, 17: 16966
interactions with nucleons at 100 Bev, energy distribution of mesons (π) from, 17: 16971
interactions with mesons (π) chirality and structure of, 17: 16989
interactions with antinucleons, hyperon isobars from, 17: 16995
interactions with hyperons (Λ^0) in $_{\Lambda}H^3$ and $_{\Lambda}H^4$, 17: 17014
interactions with mesons (π), Regge-pole analysis of, 17: 17038
interactions with baryons and mesons, Regge asymptotic amplitudes for, 17: 17046
interactions with nucleons, coupling constant and spectral functions of scattering amplitude for, 17: 17054
interactions with mesons (K) and (π), angular distribution of particles produced near threshold in, 17: 17098
interactions with leptons, lecture on theory of weak, 17: 17302
interactions with leptons, theory of weak, 17: 17309
interactions with mesons, Regge trajectories in, 17: 16770(R) (ANL-6666)
level density in p-shell, calculation of, 17: 17070
pairing relations for, effects of superconducting, 17: 17307
residual pair forces between, in light nuclei, 17: 17275
scattering of, optical potentials obtained from analyses of elastic, 17: 17204
theory, eightfold-way assignments in, 17: 17043
transfer theory for, 17: 17123(R) (TID-18127)
NUCLEOPROTEINS
radiation effects on aqueous solutions of, 17: 15771
radiation effects on, 17: 15789

O

OAK RIDGE
meteorological data for, 10-year survey, 17: 16264 (ORO-199)
OCEANOGRAPHY
analysis of ocean-bottom cores for elemental content, neutron activation method for, 17: 15886 (TID-18125)
OILS
radiosensitivity effects of, in seeds, 17: 15763
OLIVE OIL
effects of, on radiation injuries in mice, 17: 15813
OPTICAL SYSTEMS
design for observing plasma, 17: 17332(R) (ORNL-3392(p.28-46))
ORES
analysis of, for iron, manganese, niobium, tantalum, and tin, x-ray spectrum, 17: 15900
ORGANIC ACIDS
reactions with metals, complexing, 17: 15918
ORGANIC COMPOUNDS
book: *Radiation Effects on Organic Materials*, 17: 16094
decomposition products, infrared spectroscopic analysis of, 17: 15862(R) (ORNL-3397(p.121-3))
preparation and purification, 17: 15860(R) (ORNL-3397(p.113-16))
radiation chemistry of pure, 17: 16097
radiation effects, electron spin resonance studies, 17: 15547
radiation effects on electron paramagnetic resonance spectrum of, 17: 16067
radiation effects on radioisotope-labeled, 17: 16083
radiation effects on, mechanisms of, 17: 16096
radiation effects on, potential benefits from, 17: 16109
radiation effects on, design and operation of in-pile loops for studying, 17: 16074
synthesis by electric discharges, 17: 15579
synthesis induced by high-energy electrons, 17: 16072
ORGANIC COMPOUNDS, METALLO-
triphenylchlorostannane, Mossbauer spectra of, 17: 16013
ORGANIC COOLED REACTORS
coolants for, use of combustible, 17: 17584(P)
ORGANIC MODERATED REACTORS
coolant analysis, guide for gamma pulse-height, 17: 17543 (NAA-SR-Memo-7521(Rev.))
design of experimental fluidized-bed, 17: 17428 (WCAP-1635)
OSCILLOGRAPHS
design of, for pulse techniques, 17: 16461
OSMIUM
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
OSMIUM ALLOYS
Os–Pu, phase diagram, 17: 16567
OSMIUM ISOTOPES Os-186
decay schemes, 17: 17213
OXIDASES
effects of lipoxidase on radiation injuries in mice, 17: 15813
radiation effects on glucose, 17: 15774
OXIDATION
effects of metal imperfections on, 17: 16583(R) (EURAEC-545)
OXIDES
determination of, in metals, ignition methods for, 17: 15933
free energies and heats of formation of reactive-metal, 17: 16568
sintering, review of lattice defects in, 17: 16534
OXYGEN
additive effects on titanium, 17: 16580(P)
adsorption of, by tantalum foils, determination by resistance measurements of, 17: 16719
determination in alkali metals, flame photometric, 17: 15855(R) (ORNL-3397(p.38-54))
determination in helium, comparison of methods for, 17: 15855(R) (ORNL-3397(p.38-54))
determination in sodium, 17: 15878(R) (NDA-2154-5)
determination in sodium, continuous meter for, 17: 15889(R) (UNC-5050)
determination in uranium and plutonium carbides by vacuum fusion methods, 17: 15872 (AERE-R-4216)
determination of, in uranium fission products, 17: 15892
effects on radioinduced graft polymerization, 17: 16041(R) (NCSC-2477-10)
effects on radiosensitivity of tumor cells, 17: 15688
electric discharge in, ionization processes in, 17: 16812
photoionization cross sections for five-times ionized, 17: 16791(R) (TID-18231)
proton reactions on, ionization cross sections in, 17: 16886
proton scattering from 8.5 to 13.6 Mev, elastic and inelastic, 17: 17300
radiosensitivity effects on glucose oxidase and riboflavin, 17: 15774
radiosensitivity effects on β-lactoglobulin, 17: 15778
radiosensitivity effects on red cell membranes, 17: 15787
radiosensitivity effects, 17: 15794
radiosensitivity effects of, hypothesis for, 17: 15795
sticking factors for, on titanium film, 17: 17337(R) (ORNL-3392 (p.86-8))
OXYGEN IONS
Coulomb excitation of rare-earth nuclei by, 17: 17291
OXYGEN ISOTOPES O-16
bremsstrahlung reactions (γ,p) at 24 Mev, cross sections for, 17: 17155
deuteron reactions (d,n) and (d,p) on, knock-out mechanism in, 17: 17168
deuteron reactions (d,α) on, angular distributions from, 17: 17171
fission of bismuth-209 and gold-197 by, 17: 17225
interactions with alpha particles (α,γ), dependence upon resonance levels, 17: 16916
reactions with nuclei, compound nucleus formation cross sections for,

17: 17118 (JINR-P-1162)
OXYGEN ISOTOPES O-18
electron scattering at 150 Mev, 17: 17120 (LAL-1029)
exchange in carbon dioxide, radioinduced, 17: 15976
exchange reactions with vanadium pentoxide, kinetics and mechanisms of, 17: 15979
residual pair forces in nuclei of, 17: 17275
OXYGEN SYSTEMS
C–O–U, phase studies, 17: 16522(R) (NCSC-2663-10)

P

PACIFIC OCEAN
cesium-137 content in eastern, from fallout, 17: 16299
cesium-137 content in eastern, variations, 17: 16300
PACKAGE POWER REACTORS
design studies for gas-cooled, 17: 17541(R) (IDO-28602)
PACKED COLUMNS
operation for isotope separation, theory, 17: 16492
PAIR PRODUCTION
cross sections for high-energy, effective differential and integral, 17: 17105 (DESY-A-2.96)
on protons, processes in, 17: 16961
PALLADIUM
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
effects on gas absorption by thorium-containing getter, 17: 16620(P)
paramagnetic resonance of gadolinium ions in, in presence of rare earth impurities, 17: 16819
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
PALLADIUM ISOTOPES Pd-109
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
PALLADIUM ISOTOPES Pd-112
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
PALLADIUM OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
PARAMAGNETIC SALTS
magnetic spin-lattice relaxation in, mechanisms for direct, 17: 16839
PARAMECIUM
radiosensitivity of, effects of thymine and valine with hydrogen peroxide on, 17: 15737
PARTICLE TRACKS
detection and location for direct computer analysis, 17: 16427 (PPAD-461E)
distributions from 24 Bev-proton reactions on nuclei, 17: 17161
PARTICLES
size distribution in natural radioactive aerosals, 17: 16279
size measurements by gravimetric and volumetric methods, design of apparatus for, 17: 15937 (AEET/CD/4)
size of, dye adsorption method for determination of, 17: 15938 (AEET/CD/5)
PASSIVATION
aluminum–stainless steel coupling effects on, 17: 16584(R) (EURAEC-550)
PENTANE, 2-METHYL-
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)
PENTANE, 2,2,4-TRIMETHYL-
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)
1-PENTENE, 2,4,4-TRIMETHYL-
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)
PEPTIDES
analysis of iodine-131- and tritium-labeled angiotensin for biological potency, 17: 15597
chromium-51 distribution in poly-, in hemoglobin, 17: 15593
radiation chemistry of solid, 17: 16071
synthesis of carbon-14-labeled glycyl-, 17: 16035
PEROXIDES
radioinduced reactions with aryl amines to form diaryl nitrogen oxide radicals, 17: 16064
radiosensitivity effects on purines and pyrimidines, 17: 15779
PERSONNEL
monitoring of, performance of film badges for, 17: 16433
monitoring of, role of film badge in, 17: 16432
radiation exposure monitoring at Argonne National Laboratory, analysis of data from, 17: 16312 (ANL-6688)
radioactive contamination of, hazards and monitoring of internal, 17: 16334
PERTURBATION THEORY
analytic and convergence properties of linked cluster expansion, 17: 17074
analyticity and boundedness of three-point function in, 17: 16824
Fermi gases in, 17: 17062
formalism for many-body problem at nonzero temperatures, 17: 17063
formalism for many-body problem at nonzero temperatures, 17: 17071
formalism for many-body problem at nonzero temperatures, 17: 17072
ground state theory of imperfect Fermi gases in, 17: 17061
interactions in nuclear matter in, velocity-dependent, 17: 17164
linked-cluster expansions of partition function of gases in, 17: 17065
meson (π) resonances in, 17: 17037
meson relations to Regge poles in, vector, 17: 17045
models for small-angle particle scattering in, 17: 16999
nucleons as Regge poles in, 17: 17038
photomeson (π) production on nuclei in, 17: 17163
singularities in electron-proton scattering amplitudes in, 17: 16997
PERYLENE
spectra of chloranil complexes of, 17: 16785 (NYO-3062)
PETROGRAPHY
applications of isotope effects in studies of, 17: 15554
PHENATINE
radiosensitivity effects, 17: 15841
PHENETHYLAMINE
N,α-dimethyl-, protective effects of, against radiation in mice, 17: 15826
PHENETHYLAMINE, α-METHYL-
protective effects of, against radiation in mice, 17: 15826
PHENOL, DICHLORO-
protective effects against radiation, metabolic factors in, 17: 15794
PHENOL, DINITRO-
protective effects against radiation, metabolic factors in, 17: 15794
PHENOTHIAZINES
protective effects against radiation, metabolic factors in, 17: 15794
therapeutic effects on illness in radiotherapy, 17: 15832
PHOSPHATES
isotopic exchange in soils, 17: 15581
pyridoxal-5-, protective effects of, against radiation in mice, 17: 15826
PHOSPHINE SULFIDE, TRIS(1-AZIRIDINYL)-
toxic effects in mice and dogs, effects of bone marrow infusions, 17: 15548
PHOSPHITES
use of, for fixation of fission product ruthenium in waste solids, 17: 17618 (ORNL-TM-263)
PHOSPHORESCENCE
extinction of, temperature dependence of, 17: 16089
PHOSPHORIC ACID, ALKYL ESTERS
spectra of salts of, infrared, 17: 16000
PHOSPHORIC ACID, ARYL ESTERS
spectra of salts of, infrared, 17: 16000
PHOSPHORIC ACID, ESTERS
proton magnetic resonance of, relations with concentration in solutions, 17: 16034 (TID-18170)
PHOSPHORS
development of liquid, 17: 15858(R) (ORNL-3397(p.71-112))
development of manganese-activated calcium fluoride, 17: 16416(R) (AD-283918L)
PHOSPHORUS
determination by x-ray spectrometry using electron-beam excitation, 17: 15908
distribution of foliar-applied, in corn and soybean plants, tracer study, 17: 15590(R) (TID-18161)
PHOSPHORUS ISOTOPES P-31
proton reactions (p,γ) on, resonances in, 17: 17173
PHOSPHORUS ISOTOPES P-32

decay of, in transforming DNA, biological effects of, 17: 15599
distribution of, in *Phaseolus vulgaris* L. during seed germination and young plant development, 17: 15551
effects of, on HeLa cells in tissue cultures, 17: 15707
formation cross sections in proton reactions, 17: 17149
incorporation of, into colloidal complex, 17: 15714
measurements in hair, estimation of fast neutron doses by, 17: 16315 (LADC-5359)
radiation effects on uptake of, by DNA and RNA in rat skin, 17: 15694
therapeutic use in chronic lymphocytic leukemia, 17: 15697
transmutation in yeasts, biological effects of, 17: 15793
uptake by, plankton, plants, and sand in water basins, 17: 15622

PHOSPHORUS SYSTEMS
Fe–Nb–P, phase studies of, 17: 15971

PHOSPHORYL CHLORIDES
chlorine-36 exchange from, to metal chlorides, 17: 15996

PHOTOCHEMISTRY
development of x ray sources for, 17: 16044 (TID-18144)

PHOTOELECTRIC EFFECT
determination of h/e, method for, 17: 16809
theory of, for alkali metals, 17: 16797(T) (UCRL-Trans-907(L))

PHOTOGRAPHIC EMULSIONS
interaction between 9-Bev protons and heavy nuclei in, angular correlation of tracks and fragments of, 17: 17262

PHOTOGRAPHIC FILM
latent-image fading and sensitivity of, 17: 16459

PHOTOGRAPHIC FILM DETECTORS
design of filtered, for personnel monitoring, 17: 16432
latent-image fading and sensitivity of personnel-badge, 17: 16459
performance of, for personnel monitoring, 17: 16433
properties of, for personnel monitoring, 17: 16432

PHOTOGRAPHY
of spark discharge radiation spectra, 10^{-9} sec time resolution in, 17: 16393(T)
Schlieren, of orthogonal pinch effect, 17: 17355

PHOTOMESONS
production of (π) on nuclei, analysis by N/D method, 17: 17163

PHOTOMETERS
development of flame, 17: 15851(R) (ORNL-3397(p.1-16))

PHOTOMULTIPLIER TUBES
circuit for producing fast coincident pulses in scintillation counting, 17: 16472(P)
counting rate of RCA 1P28, low-frequency fluctuations in, 17: 16456
stabilization of, circuitry for, 17: 16780(R) (ISS-62/23)

PHOTON SHOWERS
fluctuations of the number of particles in, determination by ionization losses, 17: 16935

PHOTONS
interactions at high energies in crystals, review, 17: 17179
interactions with electrons, low-frequency, high-intensity elastic, 17: 17008
scattering cross sections for, elastic, 17: 17153

PHOTOPROTONS
angular and energy distributions from lithium, beryllium, boron, and carbon at 140 to 190 Mev, 17: 17295
energy distribution from magnesium-24, -25, and -26, 17: 17152
energy spectrum from (γ,p) reactions with sulfur-32, 17: 17155

PHTHALIC ACID
phosphorescence of boron activated, 17: 16089
phosphorescence of, temperature dependence of duration and intensity of, 17: 16090
tetrachloro-, analytical use of, for separation of scandium and thorium, 17: 15909

PHYSICS
book: *Theoretical Physics*, 17: 17401(T)
computers in experimental, 17: 16789 (TID-18145)
research at Sanita subsection of INFN, 17: 16780(R) (ISS-62/23)

PILOCARPINE
radiation effects on toxicity of, on mice, 17: 15678

PINCH EFFECT
diffusion in one-dimensional, boundary condition for current-layer, 17: 17369
diffusion in one-dimensional, boundary conditions for current-layer, 17: 17370
photography of orthogonal, Schlieren, 17: 17355

PIPERAZINE
2-methyl- dithioformate, protective effects of, against radiation damage to liver in mice, 17: 15809

PIPES
seal design for concentric pair of ducts, 17: 16201(P)
sealing plug design for reactor standpipes, 17: 16211(P)
thickness measurement of insulated, gamma-ray caliper for, 17: 16411(P)

PIQUA POWER REACTOR
core temperature distribution in, analysis of 61- and 85-element configurations, 17: 17544 (NAA-SR-Memo-7952)

PLANETS
intelligent life on, possibilities for, 17: 17610

PLANKTON
fission product adsorption and metabolism in, 17: 15609
phosphorus-32 uptake by, in water basin, 17: 15622

PLANT CELLS
radiation effects on growth in leaves, 17: 15651
radiation effects from incorporated tritium, on growth and development, 17: 15653
radiosensitivity of root, 17: 15728

PLANT METABOLISM
of strontium and phosphorus, distribution after foliar application, tracer study, 17: 15590(R) (TID-18161)

PLANT PHYSIOLOGY
foliar absorption and translocation of nutrients, effects of wetting agents, 17: 15557

PLANTS
breeding programs for rice employing radioinduced mutations, 17: 15564
breeding programs for rice employing radioinduced mutations, 17: 15566
carbon-14 content in thymol from essential oils, annual variation, 17: 15618
distribution of phosphorus-32, calcium-45, and zinc-65 in, during seed germination and plant development, 17: 15551
phosphorus-32 uptake by, in water basin, 17: 15622
radiation effects on a natural community, 17: 15727
radiation effects, 17: 15749
radiation effects on a natural community of spring annuals, 17: 15801
radioinduced mutations, 17: 15541(R) (ORO-598)
radioinduced mutations, 17: 15563
radioinduced mutations in coffee, 17: 15565
radioinduced mutations in spinach, 17: 15682
radiosensitivity, effect of ploidy, 17: 15729
variation in rhizobia, effects on radiation, 17: 15649

PLASMA
analysis of, from titanium plasma gun with hydrogenated electrodes, spectroscopic, 17: 17380
behavior in magnetic field, 17: 17360
book: *Physics of Fully Ionized Gases*, 17: 17386
characteristics at high frequencies, virial theorem for, 17: 17372
charged particle escape from, in magnetic field, 17: 17379
confinement of, optimum energy for, 17: 17365
containment devices for high-energy, 17: 17390(P)
decay and formation of, in hydrogen molecular-ion dissociation, 17: 17331(R) (ORNL-3392(p.11-27))
density and temperature of, in absence of thermodynamic equilibrium, 17: 17382
density fluctuations in nonequilibrium plasma, 17: 17350
dielectric susceptibility of, in states with population inversion, 17: 17374
diffusion in one-dimensional pinch, boundary condition for current-layer, 17: 17369
diffusion in one-dimensional pinch, boundary conditions for current-layer, 17: 17370
electric conductivity of fully ionized, rigorous calculation of high-frequency, 17: 17325 (MATT-130)
electric conductivity of, effect of ion correlations on high-frequency, 17: 17358
electric current sheets in accelerated, 17: 16887
electromagnetic-wave propagation by glow-discharge, 17: 16889

electromagnetic wave dispersion function in, with Cauchy distribution, 17: 17357
electromagnetic wave propagation by, 17: 17373
electron and ion diffusion across magnetic field in, Brownian motion treatment of, 17: 17340 (TID-18115)
electron distribution function of anisotropic inhomogeneous, in modulated electric field, 17: 17347
electron runaway in neutral, longitudinal oscillations accompanying, 17: 17344
energy distributions and potential gradients in, 17: 17323 (ARL-62-471)
equation of state and energy function of perfect Fermi-Dirac gas for arbitrary temperature and degeneracy, heuristic approximations to, 17: 17343
field reversal in tenuous cesium, apparatus for, 17: 16790 (TID-18216)
heating and production, design of apparatus for, 17: 17391(P)
heating in stellarators, magnetic compression, 17: 17326 (MATT-133)
injection of heated, by carbon arcs, 17: 17333(R) (ORNL-3392(p.47-8))
instability of partially ionized, in crossed electric and magnetic fields, 17: 17356
ionization formulas for steady-state and transient, 17: 17382
kinetic equations for, 17: 17367
kinetic equations for, 17: 17368
kinetic properties of rarefied, with large radiative pressure and mutual electron-photon drag effects, 17: 17384
magnetic interaction effects in moving, 17: 17345
magnetoplasma resonances in, in metals, 17: 16841
microwave density of, 17: 17371
motion of one-dimensional, interacting through electrostatic field, 17: 17359
nitrogen recombination coefficients in, 17: 16888
oscillations and wave propagation in super-high frequency, 17: 17388
oscillations in, Cherenkov-like radiation by, 17: 17341 (TID-18225)
oscillations in, nonlinear properties of, 17: 17327 (ML-874)
oscillations in, theory of, 17: 17375
oscillations of potassium, low-frequency, 17: 17362
particle dynamics in bounded, 17: 17366
particle orbits in, program for calculating and plotting, 17: 17335(R) (ORNL-3392(p.56-65))
performance of thermonuclear, for space propulsion, 17: 16891
physical characteristics of arc generator stream of, effects of polarity on, 17: 17385
population inversion in, negative tensor susceptibility for, 17: 17374
production and injection of, design of coaxial gun for, 17: 17354
production by electron-cyclotron resonance in magnetic mirror geometry, neutron emission and microwave noise from, 17: 17332(R) (ORNL-3392(p.28-46))
production of high-density proton, in magnetic mirrors, 17: 17338(R) (ORNL-3392(p.89-93))
properties of, dielectric formulation of, 17: 17075
properties of, from dissociation of hydrogen molecular-ion beam, 17: 17330(R) (ORNL-3392(p.1-10))
properties of, in travelling-field accelerators, 17: 16771(R) (ASD-TDR-62-1105)
proton and meson (π) slowing down by electrons in dense, 17: 17268
rotation of electrodeless gun, 17: 17361
rotational magneto-mechanic effect in low-pressure, 17: 17383
shock wave propagation in quasi-neutral two-dimensional, in magnetic field, 17: 17377
source of, research on oscillating-electron, 17: 17323 (ARL-62-471)
sources of, investigation of, 17: 16771(R) (ASD-TDR-62-1105)
spectra of, electron and ion line widths in, 17: 17324 (GAMD-927)
stability of, computation and theory of, 17: 17335(R) (ORNL-3392 (p.56-65))
stability of conducting cylindrical, in magnetic field, 17: 17376
stability of cylindrical jet in magnetic field, magnetohydrodynamic equations for, 17: 17349
stability of rotating pinch, 17: 17381
thermal equilibrium, evolution, 17: 16827
transport coefficients of magneto, in a-c field and temperature gradient, 17: 17351
turbulence in relativistic, statistical theory of uniform isotropic, 17: 17348
wave coupling at discontinuity in, electromagnetic-magnetohydrodynamic, 17: 17363
wave propagation in two-component, analysis of, by boundary-value "piston problem", 17: 17389

PLASMA JETS
design of improved arc torch, 17: 16220(P)
production for space propulsion, travelling-wave accelerator for, 17: 16771(R) (ASD-TDR-62-1105)

PLASTIC DEFORMATION
point defects formation in, 17: 16657 (TID-16506)

PLASTIC FILMS
electron energy loss in Formvar, 17: 15765

PLASTICS
radiation effects, 17: 16099
radiation effects, 17: 16724

PLATINUM
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)

PLOWSHARE PROJECT
application of nuclear explosives for peaceful uses, bibliography on, 17: 15534 (TID-3522(Rev.6))
earth motion measurements from Gnome shot, 17: 16265 (PNE-111F)

PLUTONIUM
alloying behavior in relation to atomic size and valency, 17: 16566
arc spectra of, classification of, 17: 16801
book: *The Metal Plutonium*, 17: 16550
burnup in light water moderated reactors, development of model of, 17: 16738(R) (GEAP-4081)
chemical properties, 17: 16551
chemistry and metallurgy of liquid, 17: 17439
contraction and expansion of, during cooling, 17: 16669
criticality studies, 17: 16941 (RFP-63)
crystal structure of beta, 17: 16648 (LADC-5373)
density of, first determination of, 17: 16553
determination in uranium mixtures, comparison of methods for, 17: 16524(R) (NUMEC-P-103)
development as reactor fuel, 17: 17444
discovery, 17: 16551
dissolution by sulfamic acid, 17: 15957 (TID-16387)
half life, first measurement of, 17: 16552
handling facilities for, at ANL, 17: 16555
handling of, equipment for, 17: 16558
handling of, equipment and techniques for, 17: 16563
mechanical properties of compressed α, effects of purity and temperature on, 17: 16646 (LADC-5330)
melting point, 17: 16561
metallurgy of, review of 1943–45 work on, 17: 16554
micrography of, techniques for, 17: 16565
phase transformation temperatures, 17: 16561
phase transformation temperatures, 17: 16562
physical properties, 17: 16563
physical properties, 17: 16564
physical properties, 1945 data on, 17: 16554
precipitation of, with thorium and uranium peroxides, 17: 16079
preparation and properties of, review of work in Great Britain on, 17: 16557
preparation of, microscale, 17: 16553
properties and structure, 17: 16559
properties as reactor fuel, 17: 16555
properties as reactor fuel, 17: 16569
properties in fluid fuel reactors, 17: 16574
properties of, for use as power-reactor fuel, 17: 16517 (HW-SA-2872)
separation from fission products and uranium by gradient multistage extraction using TBP, 17: 16158
separation from irradiated fuels, design of glove boxes for Plutonium Reclamation Facility for, 17: 16141 (HW-68442)
separation of, from hydrochloric acid by solvent extraction using trioctylamine, 17: 16156
separation of pure, 17: 16552
solubility in bismuth, 17: 16574
spectra of, hyperfine structure and isotope shift in, 17: 15946 (CEA-2238)

thermal expansion data from −180° to 640°C, 17: 16561
thermal expansion coefficients, 17: 16562
use in paste fuel fast reactor, 17: 16575
x-ray diffraction pattern of, 17: 16560
x-ray M absorption spectrum, 17: 16814
PLUTONIUM ALLOYS
development as reactor fuel, 17: 17444
properties as reactor fuel, 17: 16569
Al–Pu, chemistry and metallurgy of, 17: 17439
Al–Pu, development at Chalk River, 17: 16556
Al–Pu, phase diagram, 17: 16567
Al–Pu, preparation and properties, 17: 16558
Al–Pu, preparation, 17: 16568
Al–Pu, preparation for NRX fuel elements, 17: 16570
Be–Pu, neutron yield from, 17: 16556
Be–Pu, phase diagram, 17: 16567
Be–Pu, preparation, 17: 16568
Bi–Pu, phase diagram, 17: 16567
Co–Pu, crystal structure of Pu_2CO, 17: 16647 (LADC-5363)
Cr–Fe–Pu, fabrication for high-temperature fuels, 17: 15532(R) (BMI-1607(Del.))
Cr–Pu, phase diagram, 17: 16567
Cu–Pu, phase diagram, 17: 16567
Fe–Pu, phase diagrams, 17: 16566
Fe–Pu, phase diagram, 17: 16567
Ga–Pu, preparation, 17: 16568
Hf–Pu, phase studies, 17: 16566
In–Pu, preparation, 17: 16568
Mg–Pu, preparation, 17: 16568
Mn–Pu, phase diagram, 17: 16567
Mo–Pu, phase diagram, 17: 16567
Mo–Pu–U, radiation effects on, 17: 16572
Ni–Pu, phase diagram, 17: 16567
Os–Pu, phase diagram, 17: 16567
Pb–Pu, phase diagram, 17: 16567
Pu–Ag, preparation and properties, 17: 16556
Pu–Th, phase diagram, 17: 16566
Pu–Th, phase diagram, 17: 16567
Pu–Th, preparation, 17: 16568
Pu–Th, radiation effects on, 17: 16572
Pu–Ti, phase studies, 17: 16566
Pu–Tl, preparation, 17: 16568
Pu–U, phase diagram, 17: 16566
Pu–U, preparation, 17: 16568
Pu–U, properties as reactor fuel, 17: 16571
Pu–U, radiation effects on, 17: 16572
Pu–V, phase diagram, 17: 16567
Pu–Zr, chemistry and metallurgy of, 17: 17439
Pu–Zr, phase studies, 17: 16566
Pu–Zr, radiation effects on, 17: 16572
U–Pu, phase diagram, 17: 16567
Zr–Pu, phase diagram, 17: 16567
PLUTONIUM CARBIDES
analysis for oxygen, vacuum fusion methods for, 17: 15872 (AERE-R-4216)
properties of arc-cast mono-, 17: 16688
thermionic emission constants of, 17: 16783 (LADC-5128)
PLUTONIUM COMPOUNDS
development as reactor fuel, 17: 17444
PLUTONIUM(III) FLUORIDES
reduction by aluminum, 17: 16568
PLUTONIUM(VI) FLUORIDES
radioinduced decomposition, 17: 16045 (TID-18184)
PLUTONIUM HALIDES
reduction of, review of early studies of, 17: 16553
PLUTONIUM(IV) IONS
chemical properties in aqueous nitrates, spectrophotometric study of, 17: 15854(R) (ORNL-3397(p.26-38))
ion exchange on Dowex resin in nitric acid, effects of water-phase plutonium concentrations, 17: 16143 (LADC-5377)
PLUTONIUM ISOTOPES
use in thermal and fast reactors, evaluation of, 17: 16524(R) (NUMEC-P-103)
PLUTONIUM ISOTOPES Pu-238
alpha emission, energy of intense groups, 17: 17143
PLUTONIUM ISOTOPES Pu-239
alpha emission, energy of intense groups, 17: 17143
biological effects of injected, on swine bone, 17: 15847
effects on blood picture in dogs and rabbits, 17: 15741
magnetic moment of, determination of, 17: 17131
maximum permissible limits in air, 17: 16555
neutron fission of, first demonstration of, 17: 16551
neutron resonance integrals for, fast, 17: 17470
nuclear magnetic moments, 17: 15946 (CEA-2238)
nuclear magnetic resonance of, search for, 17: 16563
PLUTONIUM ISOTOPES Pu-240
alpha emission, energy of intense groups, 17: 17143
neutron resonance integrals for, fast, 17: 17470
PLUTONIUM ISOTOPES Pu-241
neutron resonance integrals for, fast, 17: 17470
PLUTONIUM NITRATES
analysis for nitrates and nitric acid, volumetric, 17: 15875 (HW-76363)
separation of, by solvent extraction using tertiary amine nitrates, 17: 16154
PLUTONIUM NITRIDES
fabrication, 17: 15532(R) (BMI-1607(Del.))
PLUTONIUM OXIDES
properties as reactor fuel, 17: 16576
thermionic emission constants of, 17: 16783 (LADC-5128)
PuO_2–UO_2, properties of coprecipated, 17: 16524(R) (NUMEC-P-103)
PLUTONIUM(IV) OXIDES
preparation by precipitation in hydroxide and oxalate solutions, 17: 16524(R) (NUMEC-P-103)
reduction by aluminum, 17: 16568
sintering studies, on hydroxide precipitated, 17: 16524(R) (NUMEC-P-103)
PuO_2–UO_2, fabrication and radiation behavior of fuel cycle specimens, 17: 17409(R) (GEAP-3811)
PuO_2–UO_2, sintering studies on oxalate precipitated, 17: 16524(R) (NUMEC-P-103)
PLUTONIUM RECYCLE TEST REACTOR
design, 17: 16573
reactivity transients in, following helium line failure at pressurizer, calculations of, 17: 17540 (HW-75731)
PLUTONIUM SYSTEMS
C–Fe–Pu, use as reactor fuel, 17: 16577(P)
Pu–Si, preparation, 17: 16568
POCKET CHAMBERS
design for neutron flux dosimeter, 17: 16474(P)
design of gas-filled, 17: 16480(P)
design of, using a compass, 17: 16431(T) (AEC-tr-5558)
development, 17: 16416(R) (AD-283918L)
POLAND
radiation processing of foods, developments, 1962, 17: 16373
POLAROGRAPHY
development of controlled-potential d-c, 17: 15851(R) (ORNL-3397 (p.1-16))
electrodes for glass corroding solutions, development of dropping-mercury teflon, 17: 15852(R) (ORNL-3397(p.17-24))
sensitivity of d-c, effects of various mercury cathodes on, 17: 15851(R) (ORNL-3397(p.1-16))
POLONIUM
effects of, on intestinal microflora and radiation sickness in dogs, 17: 15815(T)
separation from ethylenediamine acetate solutions, electrolytic and chemical, 17: 16150(T) (CEA-tr-A-1291)
POLONIUM ISOTOPES Po-196
alpha decay to total decay probability ratio, 17: 17256
POLONIUM ISOTOPES Po-198
alpha decay to total decay probability ratio, 17: 17256
POLONIUM ISOTOPES Po-200
alpha decay to total decay probability ratio, 17: 17256
POLONIUM ISOTOPES Po-204
alpha decay to total decay probability ratio, 17: 17256

POLONIUM ISOTOPES Po-210
maximum permissible limits in air, 17: 16555
POLONIUM ISOTOPES Po-212
decay of, energy distributions of recoil nuclei in formvar films from alpha, 17: 17249
spin in I = 16 level of isomer, 17: 17271
POLYMERIZATION
radiation process for improved dyeability, 17: 16112(P)
radioinduced graft, fiber property effects of, 17: 16041(R) (NCSC-2477-10)
radioinduced in unsaturated monomers, 17: 16122(P)
POLYMERS
crystallinity and flow temperature of graft copolymers produced by irradiation, 17: 16081
radiation curing method for, 17: 16114(P)
radiation effects, 17: 16098
radiation effects on petroleum-derived, 17: 16116(P)
radiation effects on polyester resins with polyunsaturated polyester modifiers, 17: 16115(P)
radiation effects on polyester resins with polyunsaturated polyalkenyl aryl modifiers, 17: 16118(P)
radiation effects on polyester resins with polyunsaturated polyether modifiers, 17: 16119(P)
radioinduced crosslinking of polyester resins, 17: 16766(P)
POLYPHENYLS
pyrolysis, mechanism of degradation-product formation in, 17: 17416(R) (IDO-16830)
radiation effects, 17: 16101
radiolysis, mechanism of degradation-product formation in, 17: 17416(R) (IDO-16830)
POLYPHOSPHATES
analysis of, by ion-exchange chromatography and spectrophotometry, 17: 15885 (TID-18119)
POPULATIONS
characteristics of abnormalities in atom bomb survivors, 17: 15824
radiation effects in plant, 17: 15727
POSITRONS
annihilation in sodium-fluoride crystals, theory of, 17: 17301
existence of galactic, 17: 16911
polarization of, method for measuring, 17: 17004
scattering by nuclei at 0.183 to 1 Bev, models for elastic, 17: 17186
POTASSIUM
content in blood cells of rabbits, 17: 15621
content of, in bone, muscles, and soft tissues in man, 17: 15603
determination in ocean-bottom cores by radiation spectra analysis, 17: 15886 (TID-18125)
distribution in rat tissues, effect of x radiation and methionine sulfoximine, 17: 15687
electric charge of neutral, upper limits for, 17: 17012
oscillations in plasma of, low-frequency, 17: 17362
photoelectric effect in, spectral distributions of normal and selective volume, 17: 16797(T) (UCRL-Trans-907(L))
sorption on tungsten, thermal accommodation of rare gases during, 17: 16027
spectra of, high energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
POTASSIUM ALLOYS
K–Na, magnetic field interactions with surface waves on, 17: 16784 (NASA-TR-R-161)
POTASSIUM BROMIDE CRYSTALS
luminescence spectra of europium-activated, 17: 16862
radioinduced color centers in, effects of dose and temperature on, 17: 16759
KCl–KBr, radioinduced color centers in mixed, 17: 16759
RbCl–KBr, radioinduced color centers in mixed, 17: 16759
POTASSIUM BROMIDES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
spectra of, infrared, 17: 15862(R) (ORNL-3397(p.121-3))
POTASSIUM CHLORIDE CRYSTALS
F-center lifetime in, 17: 15942(R) (ARF-1184-8)
luminescence spectra of europium-activated, 17: 16862
radioinduced color centers in, effects of dose and temperature on, 17: 16759
spectra of, ratio of K-band absorption to F-band absorption in, 17: 15942(R) (ARF-1184-8)
thermal conductivity of, effects of atomic admixtures on, 17: 15967(T) (SCL-T-468)
KCl–KBr, radioinduced color centers in mixed, 17: 16759
KCl–RbCl, radioinduced color centers in mixed, 17: 16759
POTASSIUM CHLORIDES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
LiCl–KCl, preparation of eutectic, 17: 15859(R) (ORNL-3397(p.112-13))
POTASSIUM CHROMATES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
POTASSIUM IODIDE CRYSTALS
luminescence spectra of europium-activated, 17: 16862
POTASSIUM IODIDES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
POTASSIUM ISOTOPES
abundances in rocks, variations, 17: 16270
POTASSIUM ISOTOPES K-39
neutron reactions (n,αγ) and (n,pγ), coincidence study of, 17: 17196
POTASSIUM ISOTOPES K-43
preparation and properties, 17: 15858(R) (ORNL-3397(p.71-112))
POTASSIUM PERRHENATES
spectra of, infrared, 17: 15862(R) (ORNL-3397(p.121-3))
POTASSIUM PERTECHNETATES
spectra of, infrared, 17: 15862(R) (ORNL-3397(p.121-3))
POTASSIUM PHOSPHATES
paraelectric response of deuterated, 17: 16017
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
POTASSIUM URANATES
structural properties for uranyl bonding, 17: 15959 (TID-18140)
POTATOES
radiation processing, effect on wholesomeness, 17: 16370 (NP-12608)
POWDER COMPACTS
fabrication radioactive, by vibration, 17: 16609(R) (NYO-10214)
POWDER METALLURGY
methods in, for fabrication of reactor materials, 17: 17443
POWER PLANTS
development for space uses, heat rejection problems in, 17: 16230(R) (PWA-2132)
POWER REACTORS
containment structures for, design and fabrication factors of, 17: 16318 (NP-12629)
design, 17: 17585(P)
design of, for generation of electricity under space conditions, heat transmission and neutron physics for, 17: 17608
design of gas-cooled, with heat exchanger, 17: 17587(P)
design of mixed-oxide plutonium-fueled, 17: 16576
design of paste fuel, 17: 16575
design of 600-Mw(e) boiling water–separate superheat, 17: 17536 (GEAP-4057)
development of small, for levels of 10 to 70 Mw, 17: 17576
economic prospects of heavy-water, 17: 17577
fuel assembly arrangement for heterogeneous, 17: 17588(P)
fuel for, applications of plutonium as, 17: 16517 (HW-SA-2872)
monitoring of in-core power distribution in, 17: 17410 (GEAP-3914)
plutonium recycling in, 17: 16572
POWER SUPPLIES
design of nuclear-thermionic, 17: 17586(P)
performance of nuclear, for space propulsion, 17: 17611
PRASEODYMIUM

content of, in marine organisms, 17: 15604
determination of, in lanthanum oxide, spectrographic, 17: 15932
PRASEODYMIUM ALLOYS
Au–Pr, crystal structure, 17: 16658 (TID-18197)
Ni–Pr, effect of annealing on coercive force of deformed, 17: 16716
PRASEODYMIUM CARBONATES
preparation by precipitation, 17: 15951 (LADC-5579)
thermal decomposition of, compound formations in, 17: 15951 (LADC-5579)
PRASEODYMIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
PRASEODYMIUM ISOTOPES Pr-141
proton reactions (p,n) on, spectra from, 17: 17226
PRECIPITATION
radioactivity detection at weather stations, probability, 17: 16267
radioactivity of, measurements in Federal Republic of Germany, January to March 1962, 17: 15624
radioactivity of, measurements in Federal Republic of Germany, April to June 1962, 17: 15625
PRESSURE DROP
measurement of, as function of system geometry of constant-diameter tubing, 17: 16232 (TID-16555)
PRESSURE TRANSMITTERS
design, 17: 16403(P)
PRESSURE VESSELS
design for quenching steam from break in primary reactor system, 17: 17514(P)
design of cooling system for walls and thermal shields in, 17: 16218(P)
design with internal bladder, 17: 16212(P)
fabrication methods for, welding techniques in, 17: 16611(T,R) (EURAEC-551)
interlock system for, 17: 16199(P)
materials for, survey of brittle-rupture properties of, 17: 16743 (TID-17682)
penetration by cables, leading-in plate for, 17: 17512(P)
radiation effects on, neutron, 17: 16732 (AES-2)
seam welds in reactor, properties and structure of, 17: 17440
PRESSURIZED WATER REACTORS
control by variation of water-d_2 concentration, 17: 17527(P)
cooling system, deposition and transport of corrosion products in, 17: 15858(R) (ORNL-3397(p.71-112))
design of 600-Mw(e) boiling water–separate superheat, 17: 17536 (GEAP-4057)
monitoring of insulating tube inside pressure tube, 17: 17513(P)
PRIORITES
content and crystal structure, 17: 15982
PRODUCTION REACTORS
fuel element design for, 17: 17482(P)
PROPANE
photochemical reactions with iodine, 17: 16038
PROPANE, 2-METHYL-
reactions with recoil carbon, effects of phase on, 17: 16078
PROPENE
radiation effects on hydrogenation of, by nickel catalysts, 17: 16084
radioinduced graft polymerization to textiles, 17: 16041(R) (NCSC-2477-10)
PROPENE, 2-METHYL- POLYMERS
radioinduced depolymerization-halogenation, 17: 16765(P)
PROPENE POLYMERS
radiation effects on physical properties, 17: 16110
PROPIONIC ACID, SODIUM SALTS
dissociation constant of alpha-deuterated-, potentiometric and spectrophotometric determination of, 17: 15990
PROPORTIONAL DETECTORS
description of neutron, for use above the atmosphere, 17: 16922
design, filling, and use of boron trifluoride, 17: 16455
design of boron-trifluoride-gas-filled, for detection of thermal neutrons, 17: 16481(P)
design of, for hard gamma and x radiation, 17: 16436
design of gas-filled, for cosmic electrons and photons, 17: 16897
performance, 17: 16353
performance, effects of recoil alpha particles, 17: 16435
PROPULSION
cesium electron bombardment ion motor, test results for, 17: 16873
comparison of solar-thermal and solar-electric-thermal, 17: 16196
development of cesium ion, 17: 17604(R) (N62-11122)
electric, design of reactor for energy requirements of, 17: 17608
heavy particle electrostatic, NASA research on, 17: 16872
methods for space, 17: 17603 (JPL-TR-32-233)
radioisotope systems for space, review, 17: 17611
research on space, advancements in, 17: 16195
systems for space, study of ion, 17: 17605(R) (N62-11311)
thermonuclear systems for space, performance, 17: 16891
travelling-wave plasma accelerator for space, development of, 17: 16771(R) (ASD-TDR-62-1105)
PROSTIGMINE
radiation effects on toxicity of, on mice, 17: 15678
PROTACTINIUM
structure, 17: 16559
PROTEINS
protective effects against radiation in nucleoprotein complexes, 17: 15771
radiation effects on desoxyribonucleo-, in spleen in mice, 17: 15706
radiation effects of x rays on metabolism of, by liver, 17: 15750
radiation effects on composition of blood-serum and hepatic, 17: 15770
radiation effects on translocation in germinating barley, 17: 15775
radiation effects on metabolism in central nervous system and liver, 17: 15781
radiation effects on rabbit tropomyosin, gamma, 17: 16379
radiation effects of alphas on surface potential of monomolecular films, 17: 16061
radiation effects, 17: 15848
radioinduced free radicals in, kinetics of, 17: 15766
radioinduced free radicals in, 17: 15767
radiosensitivity effects of, in seeds, 17: 15763
PROTON SPECTRA
energy, from p + d reaction at 5 to 10 Mev, 17: 17085
PROTONS
angular distributions from carbon-12 (α,p) reactions, 17: 17154
containment in magnetic mirrors, 17: 17338(R) (ORNL-3392(p.89-93))
effects on matter, theory, 17: 16883
elastic scattering by magnesium-24, 17: 17261
electric charge difference from electrons, upper limits for, 17: 17012
emission in deuteron reactions (d,p), study of low-lying levels by, 17: 17232
energy spectrum in hyperon (Λ) decay, 17: 16983
fission of carbon-13, mechanism for (p,p'3α), 17: 17174
formation at capture of stopped π^--mesons by light nuclei, 17: 17273
interactions of, Coulomb-interference effects in small-angle, 17: 16999
interactions with protons at 8.35 Bev, differential cross section for elastic, 17: 16950 (JINR-P-1135)
interactions with mesons (π^-) at 6.1 Bev/c, existence of f^0 particle in, 17: 16965
interactions with bremsstrahlung, photoproduction of meson (η^0) in, 17: 16987
interactions with electrons, infrared singularities in, 17: 16997
interactions with mesons (π) and(K), cross sections and polarizations for, 17: 17003
interactions with antiprotons at low energy, cross sections for annihilation and charge-exchange in, 17: 17006
interactions with deuterons at 77 Mev, cross sections for, 17: 17009
interactions with mesons (K^+) at 970, 1170, and 1970 Mev/c, elastic, 17: 17015
interactions with neutrons at 23.1 Mev, polarization in, 17: 17024
interactions with hyperons (Σ^-) at low energies, meson (π)-hyperon coupling constants for, 17: 17025
interactions with mesons (π^-) at 900 Mev, production of double-charged mesons (π) in, 17: 17028
interactions with mesons(K^-), hyperon (Y_1^*) spin from, 17: 17039
interactions with mesons (K^-), 1.66-Bev Y_1^* from, 17: 17041
interactions with mesons (K^-) at 620 to 850 Mev/c, resonances in, 17: 17042
interactions with protons at 640 Mev, spin correlation and scattering

amplitudes for, 17: 17051
interactions with protons, necessary experiment, 17: 17057
interactions with deuterons at 5 to 10 Mev, proton spectra from, 17: 17085
interactions with nuclei, excitation of collective states by inelastic, 17: 17276
interactions with photons at 350 to 6000 Mev, meson production in, 17: 16947 (ISS-62/24)
pair production on, processes in, 17: 16961
polarization, in elastic scattering by helium-3, 17: 17296
reaction with bismuth-209, thorium-232, and uranium-238 at 20 Bev, 17: 17180
reaction with nuclei, yields from, 17: 17149
reactions at 100 Mev, isomeric states from, 17: 17141
reactions of 9-Bev, with heavy nuclei, angular correlation of tracks and fragments of, 17: 17262
reactions on gas nuclei, ionization cross sections in, 17: 16886
reactions on heavy nuclei in emulsion, at 24 Bev, 17: 17161
reactions (p,α) with fluorine-19, backward peaks in angular distributions from, 17: 17188
reactions (p,γ) on phosphorus-31, resonances in, 17: 17173
reactions (p,γ) with aluminum-27, decay scheme and spin assignment for 992-kev resonance in, 17: 17200
reactions (p,n), beta transitions in model for, 17: 17189
reactions(p,n), neutron polarization from, 17: 17125 (TID-18137)
reactions (p,n) on lithium-7, polarization distributions from, 17: 17167
reactions (p,n) on nuclei, spectra from, 17: 17226
reactions (p,n) with gold, nickel, rhodium, and tantalum, at 5 to 12 Mev, 17: 17293
reactions (p,pn) with tellurium-128 and -130, isomeric cross section ratios for, 17: 16049(R) (TID-18261(p.19-23))
reactions (p,xn) at 120, 300, 480, and 600 Mev with germanium, arsenic isotope yields from, 17: 17116 (JINR-P-1157)
reactions (p,3n) with lanthanum-139, cerium-137 isomeric cross section ratios for, 17: 16054(R) (TID-18261(p.61-70))
reactions with indium and silver, cross sections and yields for fission, 17: 16053(R) (TID-18261(p.49-60))
reactions with lithium-7, neutron production cross sections for, 17: 17220
reactions with uranium-238 at 150-Mev, kinetic energies and ranges of fragments from, 17: 16051(R) (TID-18261(p.27-43))
scattering at 7 to 12 Mev experimental and optical model cross sections for elastic, 17: 16770(R) (ANL-6666)
scattering by carbon at 28 Mev, polarization in elastic and inelastic, 17: 17198
scattering by chromium-50, chromium-52, chromium-54, angular distributions for inelastic, 17: 17266
scattering by lead-208 at 31 Mev, elastic and inelastic, 17: 17292
scattering by nickel-64 and zinc-64 at 9.6 and 11.7 Mev, excitation levels determined by, 17: 17239
scattering by oxygen from 8.5 to 13.6 Mev, elastic and inelastic, 17: 17300
scattering of, on mesons(π^-) at 300 Mev to 9 Bev, calculation of propagation of forbidden collisions in, 17: 16969
slowing down of, by electrons in dense plasma and metal, 17: 17268

PSEUDOUREA, 2-(2-AMINOETHYL)-2-THIO-
effects on metabolism in irradiated lymph cells, 17: 15833
protective effects against x radiation in animal cells, 17: 15769
radiosensitivity effects on tumor cells, 17: 15747
synergistic effects with cysteine in prophylaxis and therapy of radiation injuries in monkeys, 17: 15633 (SAM-TDR-62-103)

PSYCHOLOGY
characteristics of abnormalities in atom bomb survivors, 17: 15824

PULSE ANALYZERS
design and operation of single-channel, 17: 16392
design of analog-to-digital converter for, 17: 16879
design of many dimensional, principle of, 17: 16464
design of small, AIMA-3, 17: 16465
design of two-parameter multichannel, 17: 16428 (TID-18153)
use of gamma, for determination of OMRE coolant contamination, 17: 17543 (NAA-SR-Memo-7521(Rev.))

PULSE INTEGRATORS
design of logarithmic, for count range of 10 to 100,000 impulses/sec, 17: 16391

PULSE MODIFIERS
testing for Stanford linear accelerators, 17: 17317(R) (SLAC-8)

PULSES
amplifiers for, design of linear, 17: 16880
measurement of nuclear radiation, statistical errors in, 17: 16449

PUMPS
cavitation studies of mixed-flow impellers, 17: 16244
design of drives for electric-powered, for large reactor cooling systems, 17: 17414 (HW-SA-2922)

PUMPS (LIQUID METAL)
characteristics of electromagnetic, for sodium service at 1000 to 20,000 gpm, 17: 16176 (NAA-SR-Memo-7955)

PUREX PROCESS
waste calcination, effects of magnesium and sugar on ruthenium in, 17: 17615(R) (HW-76262)

PURINES
radiolysis of, effects of inorganic peroxides on, 17: 15779
6-chloro- and 6-mercapto-, reactions with dehydrogenase, 17: 15542 (TID-18138)

PYRIDINE
radiation stability, 17: 16063

PYRIMIDINES
effects on DNA synthesis after irradiation, 17: 15782
radiation effects on content of DNA precursors in cells, 17: 15782
radiolysis of, effects of inorganic peroxides on, 17: 15779

PYRROLE
radiation stability, 17: 16063

Q

QUANTUM ELECTRODYNAMICS
singularities in electron-proton scattering amplitudes in, 17: 16997

QUANTUM MECHANICS
analytic properties and scattering amplitude of partial waves, 17: 17398
asymptotic behavior of S matrix for high angular momentum, 17: 17023
baryon eightfold-way assignments in, 17: 17043
Bloch's transport equation in, generalization of, 17: 16964
book: *Quantum Mechanics, Volume I*, Old Quantum Theory, 17: 16869
collision lifetimes in many-body processes, 17: 17030
complex partial waves, amplitudes for relativistic and nonrelativistic, 17: 16850
eigen-energies and functions in, determination of, from Maxwell-Boltzmann density operator, 17: 17396
elementary particle statistics in, possibility of unusual, 17: 16977
elementary-particle-mass quantization in, 17: 17044
error limits for electron density, spin density, and atomic form factor in, 17: 16852
field quantization in, 17: 16826
functional integrals, 17: 17066
invariant functions in nonrelativistic theory, 17: 16844
magnetic fluxoid quantization in superconductors, 17: 16838
magnetic spin-lattice relaxation mechanisms in, 17: 16839
many-particle amplitudes in relativity theory, expansion by using partial waves, 17: 17100
microvariance and microcausality in, 17: 17400
nonperturbation linked-cluster expansion of Fermi gas wave function, 17: 17077
quasi-stationary states of two-electron atomic systems, 17: 16835
rotational invariance and S matrix in nonrelativistic, 17: 16843
selection rules for non-leptonic interactions in, 17: 17000
singularities of s-matrix after a canonical transformation, 17: 16978
statistical, for negative-energy bosons and fermions, 17: 16998
transformation permutation group matrices and multishell configuration, 17: 17058
uses in nuclear models, 17: 17305
wave geometry in, for unification with relativity theory, 17: 16859

QUARTZ
performance as vials for low-level-beta scintillation counting, 17: 16458
sputtering of, by krypton ions at 4 to 30 kev, cathode coefficient for, 17: 16817

QUINOLINES
2-carboxylic acid, analytical use of, for separation of scandium and thorium, 17: 15909
8-QUINOLINOL CHELATES
with thorium, structure of, 17: 16004
8-QUINOLINOL, 5,7-DICHLORO-
analytical use of, for determination of neodymium by radiometric titration, 17: 15925
8-QUINOLINOL, 2-METHYL-
complexes of, with thorium, structure of, 17: 16004
QUINQUEPHENYL
synthesis and properties, 17: 16036

R

RABBITS
cesium and potassium contents in blood cells of, 17: 15621
gold-198 distribution in, after intravenous injections, electrophoretic patterns of, 17: 15608
radiation effects of plutonium-239 on blood serum albumen in, 17: 15741
radiation effects on buccal cells in, sensitizing effects of testosterone on, 17: 15666
radiation effects on 5-hydroxytryptamine content in small intestine in, 17: 15705
radiation effects on mitosis in crystalline lens in, 17: 15818(T)
radiation effects on methionine metabolism in, 17: 15843
radiation injuries, correlation of systemic and hematological recovery, 17: 15804 (USNRDL-TR-606)
radiation sickness prophylaxis and therapy in, 17: 15841
radiation sickness of, effects of sympathectomy on, 17: 15844
reticulo-endothelial system activity in, determination of, using gold-198 colloids, 17: 15715
RACAH COEFFICIENTS
expressions for 3-j symbols, 17: 16957 (ORNL-TM-514)
RADIATION
absorption and intensity calculations, tabulations of numerical values used in, 17: 17080
biological effects on man, review, 17: 15634 (TID-15964)
biological effects, theory, 17: 15664
biological effects on kidney, 17: 15709
biological effects of, biophysics of gene-enzyme and relay-contact systems and target theory in, 17: 15701
biological effects of, during space flight, 17: 16341
book: *Dosimetry and Radiation Protection*, 17: 16353
carcinogenic effects in mice, stimulation by injected carbon tetrachloride, 17: 15643 (USNRDL-TR-596)
cataracts induced by, characteristics of, 17: 15717
chemical effects on sulfur-35-labeled organic compounds, 17: 16083
chemical effects on polymers, 17: 16098
chemical effects on plastics, 17: 16099
chemical effects on elastomers, 17: 16100
chemical effects on organic reactor coolants, 17: 16101
chemical effects on lubricants, 17: 16102
chemical effects on adhesives, 17: 16103
chemical effects on textiles, 17: 16104
chemical effects on coatings and films, 17: 16105
chemical effects on dielectric fluids, 17: 16106
chemical effects on jet fuels, 17: 16107
chemical effects on fluid shielding materials, 17: 16107
chemical effects on coal, 17: 16108
chemical effects on explosives and solid propellants, 17: 16108
chemical effects on wood, 17: 16108
chemical effects on organic compounds, potential benefits from, 17: 16109
chemical effects on purines and pyrimidines, effects of peroxides on, 17: 15779
diffraction of, around opaque disk, 17: 16945 (GAMD-1256)
dosage determinations from a single intake of radioactive material, 17: 15628 (EIR-41)
effect on immunity in animals, 17: 15848
effects of, on activation of taka-amylase, protective effects of inorganic salts against, 17: 15592
effects of, on aging in mice, 17: 15726
effects of, on bacteriophages and *E. coli*, type analysis of dose-effect and dose-survival of, 17: 15703
effects of, on dogs, protective effects of bone marrow and spleen cells against lethal, 17: 15845
effects of, on genetic mutations and somatic anomalies in man, relation of dose to, 17: 15665
effects of, on hair growth on mice, effects of cortisone on, 17: 15822
effects of, on leukemia incidence in Japan, epidemiology of, 17: 15829
effects of, on leukemia incidence in man, 17: 15834
effects of, on mice, protective effects of dialized and whole spleen homogenates against lethal, 17: 15812
effects of, on mice, protective effects of chemicals against, 17: 15826
effects of, on micromotility of small intestine in dogs, 17: 15683
effects of, on morphology of liver in mice, 17: 15817(T)
effects of, on mouse stem cell compartment *in vivo*, 17: 15725
effects of, on toxicity of plant substances on mice, 17: 15678
effects of plutonium-239, on blood serum albumen in dogs and rabbits, 17: 15741
effects on antibody formation, whole-body exposure, 17: 15647(T) (JPRS-18020)
effects on bird populations, 17: 15635 (TID-17762)
effects on content of DNA precursors in cells, 17: 15782
effects on deoxyribonucleoproteins, 17: 15789
effects on developing nervous system, 17: 15638 (TID-18139)
effects on diploid yeast cells, recovery from, 17: 15740
effects on DNA, mechanism of, 17: 15764
effects on enzyme activity, mechanism of, 17: 15783
effects on enzyme activity, physical mechanisms in, 17: 15780
effects on erythropoiesis in rats, dose dependence of, 17: 15742
effects on immune reactions to tissue transplants in mice, 17: 15759
effects on intestinal epithelium, 17: 15632(R) (ORO-584)
effects on intestinal epithelium in white mice, 17: 15746
effects on liver tissue, 17: 15736
effects on nucleic acid content and vitality of sperm cells, 17: 15689
effects on ovulation mechanism in frogs, 17: 15743
effects on paramecia, effects of hydrogen peroxide, thymine, and valine on, 17: 15737
effects on plants, 17: 15749
effects on radiosensitivity of progeny, in mice, 17: 15630 (LADC-5401)
effects on ribonuclease activity in lymph cells, 17: 15690
emission by Stanford linear accelerator, 17: 17317(R) (SLAC-8)
from nuclear explosions, shielding of, 17: 16330 (P-1951(RAND))
genetic effects in plants, 17: 15563
genetic effects in rice plants, 17: 15564
genetic effects in coffee plants, 17: 15565
genetic effects in rice plants, 17: 15566
genetic effects in rhizobial plants, 17: 15649
genetic effects in wheat, 17: 15731
genetic effects on plants, 17: 15541(R) (ORO-598)
hazards and monitoring of internal, 17: 16334
hazards of, in uranium processing industry, 17: 16351
hazards of, review on, 17: 16336
hazards of, review on, 17: 16337
interactions with matter, elementary processes in, 17: 17156
leukopenia induction in man, prognostic significance of, 17: 15819
protection against, using β-(2-aminoethylisothiouronium) and serotonin, 17: 15747
reactions with matter, review of, 17: 16095
scattering by moving atoms, frequency redistribution of, 17: 16973
RADIATION CHEMISTRY
mechanisms of chemical effects of ionizing radiation, 17: 16096
RADIATION DAMAGE
effects of dislocations and disordered regions on, 17: 16748
RADIATION DETECTION INSTRUMENTS
descriptions of, for solar radiation monitoring, 17: 16471
design for thermal radiation, 17: 16488(P)
design for Tory II-C rocket reactors, 17: 16881
design of, for detecting molecular beams, 17: 16466
design of semiconductor-oscillator type, 17: 16483(P)
RADIATION DETECTION INSTRUMENTS (AUDIO PULSE TYPE)
design of plug-in radiation warning device, 17: 16478(P)
RADIATION DETECTION INSTRUMENTS (COLORIMETRIC)

preparation of polymer-dye films, 17: 16475(P)
preparation of polymer–halogen compound–dye dosimeter, 17: 16479(P)
RADIATION DETECTION INSTRUMENTS (ION CURRENT TYPE)
design on *n*-decade, for space uses, 17: 16879
RADIATION DETECTION INSTRUMENTS (PULSE TYPE)
design for gamma-ray well logging, 17: 16408(P)
RADIATION DETECTORS
amplifiers for, design of linear, 17: 16880
design and performance of resistance- and thermocouple-types, 17: 17410 (GEAP-3914)
design of compass for use as, 17: 16431(T) (AEC-tr-5558)
spectrum distortion by, unfolding methods for, 17: 16429 (TID-18304)
RADIATION EFFECTS
book: *Radiation Effects on Organic Materials*, 17: 16094
conference on biological, at the molecular level, 17: 15762 (STI/PUB/60)
on materials at cryogenic temperatures, 17: 16742(R) (NP-12628)
on matter, theory, 17: 16883
on mechanical and physical properties of structural metals and alloys, 17: 16763
on pearls, color change from, 17: 16120(P)
on reactor materials, 17: 16741(R) (HW-76228)
on solids, 17: 16746(R) (TID-18253)
on stress-rupture properties of high-temperature alloys, 17: 16745 (TID-18150)
target theory application to, on biological systems, 17: 15708
RADIATION INJURIES
book: *Immunology in Acute Radiation Sickness*, 17: 15848
effects of cysteamine on blood changes, 17: 15796
of kidney, 17: 15709
of spleen lymphoid centers in mice, effects of thymus on recovery from, 17: 15752
pathology in domestic animals, 17: 15541(R) (ORO-598)
protection against, effectiveness of combined chemical prophylaxis and therapy in monkeys, 17: 15633 (SAM-TDR-62-103)
protection against, effects of yeast ribonucleic acid in human cells in culture, 17: 15803 (SAM-TDR-62-85)
protection against, using drugs, action mechanisms for, 17: 15827
recovery in large and small mammals from effects of divided x-ray dose, correlation of systemic and hematological recovery, 17: 15804 (USNRDL-TR-606)
resistance to, effects of appendectomies, chemicals, and splenectomies, 17: 15754
treatment of bladder, using Albothyl instillation, 17: 15710
treatment with autologous bone marrow, 17: 15821
RADIATION PROTECTION
book: *Dosimetry and Radiation Protection*, 17: 16353
chemical, action mechanisms in mammals for, 17: 15827
evaluation of respiratory protective devices, 17: 16314 (LADC-5343)
exposure rates and measures for, of man, 17: 16348
maximum permissible dosage of radioisotopes for short-duration inhalation, 17: 16333(T) (AEC-tr-5690)
RADIATION SICKNESS
book: *Immunology in Acute Radiation Sickness*, 17: 15848
effects of injected DNA on nucleic acid metabolism in, 17: 15797
effects on adrenaline sensitivity and heart function in dogs, 17: 15840
effects on composition of hepatic and blood-serum proteins, 17: 15770
effects on intestinal secretion function, 17: 15838
effects on metastasis frequency in animals, 17: 15831
hematopoiesis restoration in, effects of bone marrow transplantation on, 17: 15843
in dogs, induced by polonium, 17: 15815(T)
mechanism of, bacteriophages as model for analysis of, 17: 15791
metabolism of sulfur-35 labeled methionine by bone marrow and spleen during, 17: 15843
of animals, effects of sympathectomy on, 17: 15844
pathology in rats exposed to chronic, low-level radiation doses, 17: 15805(T) (JPRS-18153)
prophylaxis and therapy, 17: 15841
protection against, using thyroid hormones, 17: 15673
protection against, biometrical studies of, 17: 15846
therapy using bone marrow transplantation, 17: 15837
therapy using bone marrow injections in guinea pigs, 17: 15839
treatment of slight, with phenothiazine derivatives, 17: 15832
vitamin B_{12} metabolism in rats during, 17: 15836
RADIATION SOURCES
fabrication of, development of vibratory compaction methods for, 17: 16609(R) (NYO-10214)
particle detection from, solid angle computations for, 17: 16943 (AE-101)
preparation of krypton-85, 17: 16217(P)
RADICALS
production in ethyl halides by gamma irradiation, 17: 16038
RADIO WAVES
effects of high-altitude thermonuclear explosions on myriametric, 17: 16272
ionization effect on propagation, 17: 15536
uses for detection of high-altitude nuclear explosions, 17: 16900
RADIOACTIVE CONTAMINATION
hazards and monitoring of internal, 17: 16334
RADIOACTIVE MATERIALS
handling of, design of transportation facilities for, 17: 16754
storage of, problems in, 17: 16352
transportation in USSR, regulation for, 17: 16354
RADIOACTIVE MINERALS
curium-247 occurrence in, 17: 16274
RADIOACTIVITY
distribution in soil from weapons tests, 17: 16288
fixation of fallout by ants, 17: 15620
measurement of pulses, statistical errors in, 17: 16449
monitoring of environmental, in Italy, July to December 1961, 17: 15615 (BIO/06/62)
RADIOAPPLICATORS
analysis of yttrium-90, for contaminant, 17: 15911
development for internal use, 17: 15800
RADIOAUTOGRAPHY
principles and procedures, 17: 15698
technique for tissues, stripping-film, 17: 15574
techniques using tritium for studying aluminum structure, 17: 16539
use of, for localization of tritium-labeled DNA in bacteria, 17: 15596
RADIOBIOLOGY
biometrical methods for use in, development of, 17: 15846
European research center, status, 1961, 17: 15535(T) (UCRL-Trans-904)
research projects in Canada, 1962 and 1963, 17: 15627 (CRB-1129)
RADIOCHEMICAL PROCESSING PLANTS
design, economic aspects, 17: 17450
design, instrumentation, and operation, 17: 17451
hazards associated with maximum-credible accidents in 1 ton/day spent-fuel processing in, 17: 16329(R) (ORNL-3401(p.63-72))
RADIOCHEMISTRY
problems in review, 17: 16091
reactions of atoms following radiative neutron capture, mechanisms for, 17: 16076
research in, 17: 16046(R) (TID-18261)
uses in detection of atomic explosions, 17: 16903
RADIODIAGNOSIS
effects of, on children exposed after birth and *in utero*, 17: 16339
equipment for dental, survey of, 17: 16340
of anemias, 17: 15549
of anemic states, 17: 15577
of hepatic clearance, 17: 15611
of liver diseases, 17: 15543 (UCLA-511)
RADIOGRAPHY
dental, safety measures in, 17: 16349
intensification of gamma rays by lead screens, factors for, 17: 17394
RADIOISOTOPES
containers for, design of, 17: 16355(P)
detection and measurement in atmosphere, from nuclear explosions, 17: 16902
determination of beta-emitting, in Czechoslovakian water, methods for, 17: 15616(T) (JPRS-18391)
determination of, in feces, method for, 17: 15894
determination of valence states of, 17: 15858(R) (ORNL-3397(p.71-112))
fractionation in bomb debris, logarithmic correlations, 17: 16306
gamma emission from, table of, 17: 16353

heat of vaporization of, methods for determining, 17: 16326(R) (ORNL-3401(p.39-43))
industrial uses of, review, 17: 16358 (JEN-73-SI/18)
maximum permissible dosages for short-duration inhalation, 17: 16333(T) (AEC-tr-5690)
performance in space propulsion systems, review, 17: 17611
preparation and properties of, for use as heat sources, 17: 16357 (HW-76323)
radiation dose from inhaled or injected, calculations, 17: 16311 (AHSB (RP)R-20)
separation from sulfuric acid solutions by hydroxide and sulfate anion exchange, 17: 16138 (AE-103)
tracer uses in biology and agriculture, 17: 15556
use in ablation studies, 17: 16223 (GAMD-2117)
use of, in study of wear due to friction, 17: 16377
uses, general review, 17: 16378

RADIOLOGICAL TELEMETERING SYSTEMS
design of *n*-decade, for cosmic radiation data, 17: 16879

RADIOLOGY
use for analyses of liver function, 17: 15611

RADIOMETRIC ANALYSIS
development of methods of, for lunar-surface studies, 17: 16894
use, for process analyses using non-radioactive tracers, 17: 15913

RADIOSENSITIVITY
effects of ancestral radiation exposure, in mice, 17: 15630 (LADC-5401)
effects of oxygen and sulfhydryl compounds on, hypothesis for, 17: 15795
genetic factors in mice, 17: 15680
of carcinomas, effects of 5-fluorouracil or 5-bromodeoxyuridine, 17: 15669
of chromosomes in seeds during germination, 17: 15650
of Ehrlich ascites tumor cells, effects of temperature on, 17: 15722
of human cell cultures, effects of 5-iododeoxyuridine on, 17: 15670
of plants, effects of ploidy, 17: 15729
of response to allogenic and xenogenic skin grafts in rats, 17: 15646 (USNRDL-TR-619)
of root cells, 17: 15728
of seeds, effects of moisture content on, 17: 15799
of single-stranded desoxyribonucleic acid in the native state, 17: 15720
of tumor cells, effects of oxygen, 17: 15688
of tumor predecessor, effects of previous irradiation on, 17: 15671
of tumors, 17: 15664

RADIOSTERILIZATION
of beef and shrimp, effect on wholesomeness, 17: 16365(R) (NP-12603)
of beef, effect on wholesomeness, 17: 16361(R) (NP-12598)
of beef, effects on wholesomeness, 17: 16359(R) (NP-12596)
of beef, effects on wholesomeness, 17: 16360(R) (NP-12597)
of beef, effects on wholesomeness, 17: 16364(R) (NP-12602)
of broccoli, strawberries, and sweet corn, effects on flavor and storage time, 17: 15675
of carrots, effects on wholesomeness, 17: 16367 (NP-12605)
of chicken, beef, and pineapple jam, effect on wholesomeness, 17: 16368 (NP-12606)
of eggs, effects on wholesomeness, 17: 16369 (NP-12607)
of fruit and fish, 17: 15558
of houseflies, effectiveness of, 17: 15751
of insects, effectiveness in control of fruit fly, 17: 15560
of male insects, effectiveness in control of fruit fly and blowfly, 17: 15561
of meat, effects on wholesomeness, 17: 15631 (NP-12601)
of oranges, effects on wholesomeness, 17: 16371 (NP-12609)
of pork and carrots, effects on nutritional value, 17: 16362(R) (NP-12599)
of pork, effects on wholesomeness, 17: 16366 (NP-12604)
of potatoes, effects on wholesomeness, 17: 16370 (NP-12608)
of shrimp, effects on wholesomeness, 17: 16363(R) (NP-12600)
review on, 17: 15583

RADIOTHERAPY
applications of radioisotopes, review, 17: 15800
comparative study of ortho and supervolt, 17: 15576
dosimetry of integral doses in telecurie, 17: 15569
effects of dose fractionation on induction of skin erythema, 17: 15661
effects of, on children exposed after birth and *in utero*, 17: 16339
equipment, 17: 16221(P)
eye protection in, 17: 15756
of carcinoma of cervix, effects of, on rectum and sigmoid colon, 17: 15807
of carcinomas, chemical sensitization, 17: 15669
of carcinomas of lungs in dogs, effects of direct, 17: 15830
of chronic lymphocytic leukemia with phosphorus-32, summary of 161 patients, 17: 15697
of hyperthyroidism, dosimetry of iodine-131 in, 17: 15552
of leukemic patients followed by bone marrow infusions, case studies of, 17: 15546
of skin diseases, effectiveness of, 17: 16347
of skin diseases, effects on production of skin cancer, 17: 16347
of tumors, effects of fractionated dose, 17: 15657
of tumors, effects of fractionated dose, 17: 15658
of tumors, effects of fractionated dose, 17: 15659
of tumors, effects of fractionated dose, 17: 15660
practical dosimetry in interstitial, by beta source emitters, 17: 15545
skin tumors induced by, histology of, 17: 15806
treatment of illnesses resulting from, with phenothiazine derivatives, 17: 15832

RADIUM
pathological effects of, on luminous dial painters, epidemiological follow-up of, 17: 16342
toxic effects in sheep, 17: 15541(R) (ORO-598)

RADIUM ISOTOPES Ra-226
biological effects of injected, on swine bone, 17: 15847
maximum permissible limits in air, 17: 16555

RADON
fixation of radioactive recoil decay products on atmospheric aerosols, 17: 16271

RADON ISOTOPES Rn-219
determination of, delayed coincidence counter for, 17: 16440

RADON ISOTOPES Rn-220
determination of, delayed coincidence counter for, 17: 16440

RADON ISOTOPES Rn-222
measurement in breath, laboratory air, and uranium boreholes, 17: 16417 (AERE-R-4165)
preparation of standard solutions of, 17: 16417 (AERE-R-4165)

RAMJETS
nuclear engines for, testing of Tory II-C, 17: 16881

RARE EARTH CHELATES
intramolecular energy transfer in, spectroscopic study of, 17: 16025

RARE EARTH COMPLEXES
intramolecular energy transfer in, spectroscopic study of, 17: 16025

RARE EARTH COMPOUNDS
formation of, review on, 17: 15985

RARE EARTH HALIDES
preparation, 17: 15859(R) (ORNL-3397(p.112-13))

RARE EARTH IONS
electric field parameters of, in crystals, contributions from neighboring induced moments to, 17: 15941 (AFCRL-62-945)
magnetic properties in cubic crystals, 17: 15940 (AFCRL-62-929)

RARE EARTH MINERALS
processing for ceria and thoria removal, process for, 17: 16130(P)

RARE EARTHS
content distribution in minerals, 17: 16278
content in tektites, 17: 16305
contents in earth's rocks, 17: 16277
energy levels of nuclei of, Coulomb excitation by oxygen ions, 17: 17291
properties and uses of, review on, 17: 15985
properties of alloys of, research on, 17: 16527(R) (USBM-U-1001)
separating samarium and ytterbium from concentrates of, using amalgams, 17: 16157
separation by adsorption from molten nitrates on alumina and pyrex glass, 17: 16149(T) (CEA-tr-A-1230)
separation from thorium by solvent extraction, use of fluoride ions in, 17: 16163
separation from yttrium by chromate precipitation, 17: 16168(P)
solvent extraction from Purex FTW, flowsheet development for, 17: 17615(R) (HW-76262)

RATE METERS
design for neutron flux dosimeter, 17: 16474(P)
design of, for measurements on paper chromatograms, 17: 16450
design of scintillation, 17: 16473(P)
design of transistorized, portable, fast neutron, 17: 16468
RATS
calcium-47 and strontium-85 uptake by normal and rachitic, 17: 15591
cesium-137 effects on spermatogenesis in, 17: 15704
cortisone and x-radiation effects on *Trypanosoma lewisi* infection in, 17: 15573
gold-198 distribution in, after intracardiac injections, 17: 15607
iodine metabolism, tracer study, 17: 15588 (LADC-5209)
potassium distribution in tissues, effects of x radiation and methionine sulfoximine, 17: 15687
radiation effects on developing nervous system, 17: 15638 (TID-18139)
radiation effects on immune reactions, 17: 15644 (USNRDL-TR-605)
radiation effects on free radicals in liver lipids, 17: 15672
radiation effects on regenerating liver in, 30-Mev electron, 17: 15677
radiation effects on Leydig cells in, 17: 15693
radiation effects on mitosis in skin of, 17: 15694
radiation effects on phosphorus-32 uptake by DNA and RNA in, 17: 15694
radiation effects on erythropoiesis in, dose dependence of, 17: 15742
radiation effects on central nervous system of, chronic whole-body, 17: 15744
radiation effects on embryonic nervous system of, 17: 15745
radiation effects on immunologic tolerance, 17: 15761
radiation effects of fetal x-irradiation on behavior of 100-day-old males, 17: 15655
radiation effects on leukocytes in peripheral blood in, protective effects of ribonucleic acid on, 17: 15692
radiation effects on glycogen content and vascular permeability in brain of, alpha, 17: 15695
radiation effects on 5-hydroxytryptamine content in small intestine in, 17: 15705
radiation effects, chronic, low-level exposure, 17: 15805(T) (JPRS-18153)
radiation effects on adrenocortical steroid synthesis in, whole-body, 17: 15808
radiation effects on erythropoiesis in, reactivation effects of cobalt on, 17: 15810
radiation effects on metabolism of vitamin B_{12} by, 17: 15836
radiation sickness of, effects of thyroid hormones on, 17: 15673
radiation sickness prophylaxis and therapy in, 17: 15841
radiosensitivity, effects of actinomycin D, 17: 15541(R) (ORO-598)
sorption of beta particles by skin of, protective effects of adrenaline and tannin against, 17: 15553
REACTION MECHANISMS
gas-solid kinetics at constant pressure, design of apparatus for studying, 17: 15937 (AEET/CD/4)
REACTOR COMPONENTS
design, lectures on, 17: 17403 (ANL-6640)
design of, for on-power refueling of CANDU, 17: 17532 (AMF-388-TR-2(Vol.I))
design of, graphic coverage for CANDU, 17: 17533 (AMF-388-TR-2 (Vol.II))
development, 17: 17411(R) (GEMP-177C)
development of, for LMFR and water moderated systems, 17: 17404(R) (BNL-164)
development, summary of EURATOM program for July to Sept. 1962, 17: 17441
fabrication techniques for, 17: 17448
materials development for, review, 17: 17442
radioinduced heating of EGCR core supports, 17: 17547 (TID-18095)
REACTOR CONTROL RODS
development of 2 wt.% boron-stainless steel, 17: 17531 (ACNP-63001)
drive mechanism design for, 17: 17495(P)
drive mechanism design, 17: 17516(P)
drive system for, design of electro-hydraulic, 17: 17476(P)
effective radius of, method of calculating, 17: 17421 (NAA-SR-Memo-477)
materials development for, 17: 17446
materials for, tests of, 17: 16737 (GEAP-3927)
position indication device for, design, 17: 17485(P)
research on, 17: 17419(R) (MITNE-26)
REACTOR CONTROL SYSTEMS
design for controlling flux distortions in core, 17: 17528(P)
design for power reactors with variable load, 17: 17589(P)
design for startup, 17: 17517(P)
design of fail-safe monitoring circuit, 17: 17498(P)
design of movable rods, 17: 17518(P)
design of safety release mechanism, 17: 17515(P)
design using liquid level variation, 17: 17494(P)
design with small bar displacements, 17: 17524(P)
development of circulating-ball, for reactivity, 17: 17411(R) (GEMP-177C)
development of hydraulic-ball, 17: 17412(R) (GNEC-264)
development of, lectures on, 17: 17403 (ANL-6640)
device for quenching steam from break in primary reactor system, 17: 17514(P)
instrumentation, 17: 16404(P)
instrumentation, review, 17: 17429
operation of, safety precautions in, 17: 17405 (CEA-2174)
REACTOR COOLANTS
development of new organic, 17: 17416(R) (IDO-16830)
evaluation of steam-water spray as, 17: 17406(R) (EURAEC-519)
film deposition from organic, on heated rods, 17: 17423 (NAA-SR-Memo-8088)
method for using combustible organic liquid as, 17: 17584(P)
molecular structure of polyphenyl, theory of carbon-carbon bonds in, 17: 16031(R) (TID-17275)
properties and reactions of polyphenyl, 17: 17416(R) (IDO-16830)
purification of gaseous, circuit for, 17: 17508(P)
purification of organic, by use of Attapulgus clay, 17: 15849 (CRCE-1131)
radiation effects on organic, 17: 16101
radioactive contamination of organic, determination by gamma pulse height analysis, 17: 17543 (NAA-SR-Memo-7521(Rev.))
recovery of radiolyzed-organic by hydrocracking, 17: 17416(R) (IDO-16830)
REACTOR COOLING SYSTEMS
design, 17: 16259(P)
fission gas removal from homogeneous, system for, 17: 17526(P)
pumps for, design of drive for large, 17: 17414 (HW-SA-2922)
REACTOR ENGINEERING
analogies between conventional and nuclear power sources, 17: 17415 (HW-SA-2933)
design of containment and restraint devices, for mobile uses, 17: 17487(P)
design of core composed of stacked moderator elements apertured for fuel and coolant channels, 17: 17522(P)
design of fuel loading device, 17: 17518(P)
design of NORA, 17: 17595 (KR-41)
design study of 300 Mw high-power-density systems, 17: 17535 (GEAP-3967)
four-group cross sections preparation, 17: 17422 (NAA-SR-Memo-7789)
in-core power monitoring methods, 17: 17410 (GEAP-3914)
lectures on, 17: 17403 (ANL-6640)
neutron streaming from EGCR core, current estimates of, 17: 17548 (TID-18096)
parametric studies of plutonium use in fast and thermal reactors, 17: 16524(R) (NUMEC-P-103)
power output increase in the Garigliano Plant, 17: 17539(R) (GEAP-4164)
program for sodium reactor development, 17: 17542 (NAA-SR-3740)
test for check-out of EGCR burst slug detection system, 17: 17530 (ACNP-62509)
REACTOR EXPERIMENTAL FACILITIES
control and safety systems for, 17: 17593 (HW-SA-2945)
design of fluidized-bed, organic moderated, 17: 17428 (WCAP-1635)
operation of Argonne, lectures on, 17: 17403 (ANL-6640)
REACTOR FUEL ALLOYS
composition of noncorrosive plutonium alloy for use in tantalum container, 17: 16577(P)

development of plutonium-containing, 17: 16571
development of plutonium-containing, 17: 16572
REACTOR FUEL ELEMENTS
analysis of PWR after 5806 full power hours, 17: 17574 (WAPD-T-1461)
assembly arrangement of, for heterogeneous power reactor, 17: 17588(P)
cladding developments for, 17: 17447
coating materials for, 17: 16730(P)
compatibility of composite, research programs on, 17: 15532(R) (BMI-1607(Del.))
design, 17: 17503(P)
design for high temperatures, 17: 17497(P)
design for improved heat transfer, 17: 17502(P)
design, having spaces for fertile materials, 17: 17482(P)
design, having uniform temperature distributions, 17: 17484(P)
design of concentric-cylindrical, 17: 17519(P)
design of finned, 17: 17474(P)
design of finned, 17: 17493(P)
design of finned, 17: 17505(P)
design of finned, 17: 17506(P)
design of, for fuel test loop experiments, 17: 17416(R) (IDO-16830)
design of rod-cluster, 17: 17481(P)
design, with corrugated heat-transfer surfaces, 17: 17489(P)
development and performance of, lectures on, 17: 17403 (ANL-6640)
dissolution of nichrome and stainless steel clad by nitric acid, properties of product solutions, 17: 16142 (IDO-14602)
dissolution of uranium–zirconium, 17: 16167(P)
end cap design for early warning of fault, 17: 17525(P)
fabrication and operation for preventing dilation between fuel and can, 17: 16627(P)
fabrication by swaging of powder-filled stainless steel tubes, 17: 16626(P)
fabrication of, for EBR-II, Core I, 17: 16602 (ANL-6276)
fabrication techniques for, 17: 17448
fission distribution in seven-pin, 17: 17128 (UCRL-6695)
heat removal from casks for irradiated, 17: 17545 (NAA-SR-Memo-8053)
heat transfer of rod blusters by boiling, burnout, 17: 16238
housing for, parallel-rod design of, 17: 17504(P)
materials development, 17: 17444
melting of, fission product release in, 17: 16324(R) (ORNL-3401 (p.27-35))
melting of, fission product release on in-pile, 17: 16325(R) (ORNL-3401(p.35-9))
positioning in and withdrawal from reactors, design of equipment for, 17: 17521(P)
processing of irradiated, equipment and facility for, 17: 16140 (DP-757)
processing of irradiated by nonaqueous methods, review, 17: 17452
processing of, preparation for, 17: 17451
radiation effects on encapsulated, 17: 16524(R) (NUMEC-P-103)
radiation effects on plutonium-enriched, at 2430 Mwd/t burnup, 17: 16738(R) (GEAP-4081)
radiation effects on, design of helium-cooled in-pile loop for studying, 17: 16756
shipment of, safety evaluation for packaging of, 17: 16317 (NAA-SR-Memo-8151)
shipping of spent, design and economic studies, 17: 16313(R) (EURAEC-292)
temperature, system for monitoring, 17: 17483(P)
testing in in-pile loop, 17: 16261(P)
REACTOR FUEL ELEMENTS (CERAMIC)
design for improved heat transfer, 17: 17477(P)
development, 17: 16522(R) (NCSC-2663-10)
development and properties of fiberized glass, 17: 16525(R) (NYO-9736)
development of mixed-oxide, for fast systems, 17: 17409(R) (GEAP-3811)
fabrication of boron carbide burnable poison containing, 17: 16605(R) (CEND-173)
fabrication of sheathed, 17: 16630(P)
radiation effects on Zircaloy-clad, 17: 16735 (EXP-NRX-2807)
radiation effects at exposures of 100 to 3200 Mwd/t, 17: 16739 (GEAP-4107)
REACTOR FUEL PINS
bowing characteristics of, effects of length, material, and end support on, 17: 16661 (TRG-Report-441)
design and fabrication of, 17: 17486(P)
REACTOR FUEL PLATES
welding thick-walled, methods for, 17: 17438
REACTOR FUEL RODS
fabrication of aluminum–plutonium, review, 17: 16556
fabrication of plutonium-containing, 17: 16570
support design for preventing vibration, 17: 17509(P)
vibration of, in parallel flow, 17: 17537 (GEAP-4059)
REACTOR FUEL SPHERES
design, 17: 17500(P)
fabrication of ceramic, by plasma torch, 17: 16524(R) (NUMEC-P-103)
fabrication of glass, with high thorium or uranium contents, 17: 17478(P)
REACTOR FUEL TUBES
testing of, ultrasonic, 17: 17546(R) (SRO-80)
REACTOR FUELS
analysis of irradiated, in solution, by gamma spectrography, 17: 15874 (CEA-2226)
burnup determinations, development of methods for, 17: 17426(R) (TID-17385)
coating of refractory particles of, 17: 15532(R) (BMI-1607(Del.))
costs of uranium-molybdenum alloy, analysis of, 17: 16521 (NAA-SR-Memo-2974)
development of, at APDA, 17: 17424(R) (PRDC-TR-62)
development, summary of EURATOM program for July to Sept. 1962, 17: 17441
fabrication by powder metallurgy, 17: 17443
materials development, 17: 17444
processing and transportation of irradiated, economic aspects, 17: 17450
processing, economic aspects and methods of, 17: 17449
processing of irradiated, development of analytical methods for use in, 17: 15852(R) (ORNL-3397(p.17-24))
processing of spent, evaluation of maximum-credible accidents in, 17: 16329(R) (ORNL-3401(p.63-72))
processing of, use of TBP in, 17: 16146 (ORNL-TM-527)
radiation effects on coated particles of, 17: 15532(R) (BMI-1607(Del.))
radiation effects on uranium-based, index to bibliographies on, 17: 16747 (VDIT-16(Ind.61/62))
radiation effects on reactivity of, 17: 17402 (AECL-1684)
recycling in fast-thermal complexes, economic aspects of, 17: 17413(R) (HW-74549)
separation of uranium from irradiated, development of two-stage differential extraction procedure for, 17: 16145 (ORNL-3312)
REACTOR MATERIALS
corrosion of, in radiation environment, 17: 16584(R) (EURAEC-550)
corrosion of, lectures on, 17: 17403 (ANL-6640)
development for cladding and structural uses, 17: 17447
development, summary of EURATOM program for July to Sept. 1962, 17: 17441
developments in, review, 17: 17442
fabrication by powder metallurgy, 17: 17443
fabrication techniques for, 17: 17448
radiation effects on properties, 17: 16741(R) (HW-76228)
radiation effects, 17: 16763
radiation effects on, studies of, in reactor development programs, 17: 17437
REACTOR MATRICES
buckling in uranium oxide–heavy water lattices, 17: 17402 (AECL-1684)
criticality studies of homogeneous slabs and spheres, 17: 17425 (RM-3256-PR)
design, 17: 17503(P)
design of stacked moderator elements, 17: 17522(P)
neutron distributions and capture in heavy-water, 17: 17419(R) (MITNE-26)
research on heavy-water moderated, experimental and theoretical, 17: 17419(R) (MITNE-26)
REACTOR MODERATORS
flow control for liquid, 17: 17499(P)
gas formation in organic, chromatographic study of, 17: 15855(R) (ORNL-3397(p.38-54))
materials development for, review, 17: 17445
neutron thermalization in homogeneous, 17: 17465
REACTOR OSCILLATORS

use of, to excite ATR critical experiment, 17: 16942 (TID-18064)
REACTOR REFLECTORS
model of, 17: 16940 (NAA-SR-7263)
REACTOR SAFETY
containment and operational aspects, lectures on, 17: 17403 (ANL-6640)
containment structure design and fabrication for power reactors, standards development for, 17: 16318 (NP-12629)
disposal of space nuclear auxiliary power systems at re-entry, 17: 16310 (AFSWC-TDR-62-83)
hazards evaluation of HWCTR, 17: 17592 (DP-600)
hazards of cobalt spill at NRX Reactor, July 1958, 17: 17594 (IOI-158)
of ceramic-fueled fast systems, 17: 17409(R) (GEAP-3811)
REACTOR SHIELD VOIDS
closing device for, radiological protection offered by, 17: 16214(P)
REACTOR SHIELDING
design for fuel channels, 17: 17479(P)
development of, lectures on, 17: 17403 (ANL-6640)
REACTOR THERMAL COLUMNS
design of, for EGCR, 17: 17569 (TID-18249)
REACTOR TUBES
development of twisted-rib beryllium, extrusion program for, 17: 16607(R) (NMI-4950)
monitoring of insulating tube inside pressure tube, 17: 17513(P)
radiation effects on Zircaloy-4, 17: 16734 (CVNA-159)
testing irradiated, facility for, 17: 16740 (HW-76158)
REACTORS
book: *Theory and Calculations of Nuclear Reactors*, 17: 17455
control-rod-position indicators for, design, 17: 17485(P)
cooling systems of, determination of optimum thermodynamic characteristics for, 17: 17435
design, having layers of hexagonal moderator columns, 17: 17488(P)
design of, for spherical fuel elements, 17: 17500(P)
design, with corrugated heat-transfer surfaces, 17: 17489(P)
design, with thermionic output, 17: 17586(P)
development of, role of irradiation experiments in, 17: 17437
development, summary of EURATOM program for July to Sept. 1962, 17: 17441
dynamic behavior of, bibliography on, 17: 17420 (NAA-SR-7786)
fission product release in containment vessel of, Nuclear Safety Pilot Plant for studying, 17: 16328(R) (ORNL-3401(p.57-60))
fuel burnup in, calculation method for, 17: 17464
fuel element design for, 17: 17482(P)
fuel element positioning in and withdrawal from, design of equipment for, 17: 17521(P)
fuel-pin assemblies for, design, 17: 17486(P)
fuel temperature measurement in, using no long leads, 17: 17483(P)
gamma pulse-height spectra reduction, mathematical method for, 17: 16959
hot channel and hot spot calculations for, computer programs and models for, 17: 17408(R) (EURAEC-584)
instrumentation of, lectures on, 17: 17403 (ANL-6640)
kinetics of reflected, model for, 17: 16940 (NAA-SR-7263)
loading, design of servicing mechanism for, 17: 17492(P)
loading device for, 17: 17480(P)
loading of, device for radiological protection during, 17: 16214(P)
moderator flow control, 17: 17499(P)
neutron flux calculations for, in two-group, 17: 17462
neutron flux distortions, device for correction, 17: 17528(P)
neutron flux measurements in, by bare monitors, 17: 15858(R) (ORNL-3397(p.71-112))
neutron flux peaking at sharp corners in, 17: 17092 (TID-16485)
neutron spectrum, equation for thermal, 17: 17095
power distribution measurement by radiation detection outside reactor, 17: 17510(P)
power measurement during impulse, using Cherenkov radiation, 17: 17431
reactivity temperature coefficient, equations, 17: 17430
refueling, device for monitoring coolant flow during, 17: 16254(P)
startup of, method for automatic, 17: 17517(P)
REFRACTORY MATERIALS
brazing of, exothermic, 17: 16608(R) (NP-12615)
development as reactor fuel, 17: 17444
emissivity and vaporization of, measurements of, 17: 16632(R) (AD-274654)
structure, review, 17: 16666
RELATIVITY THEORY
elementary particle interactions in, 17: 16960
elementary-particle weak interactions in, 17: 16976
field equations for gravitational energy radiation, 17: 16832
gravitational field quantization in, 17: 16826
gravitational waves in, theory of plane, 17: 16858
many-particle amplitudes, expansion of by partial waves, 17: 17100
masses in, positive, negative, and imaginary proper, 17: 16968
plasmoid existence in, denial of, 17: 16829
relativistic gas in, equilibrium distribution of, 17: 16781 (JINR-P-1159)
time dilation in, detection using Mössbauer effect, 17: 17208
uniformly accelerated motion and, transformations for, 17: 16798
wave geometry in, for unification with quantum mechanics, 17: 16859
RELAYS
reliability of radioactive, with hysteresis, method for determination of statistical, 17: 16463
REMOTE-CONTROL EQUIPMENT
design for manipulating capsules in reactors, 17: 16207(P)
design of ball-and-socket joint for through-wall controls, 17: 16219(P)
design of force-multiplying manipulator handle, 17: 16204(P)
design of magnetic, 17: 16213(P)
development of, for radioactive sample analysis, 17: 15851(R) (ORNL-3397(p.1-16))
RENÉ-41
radiation effects on stress-rupture properties, 17: 16745 (TID-18150)
RESEARCH REACTORS
design of NORA, 17: 17595 (KR-41)
design studies for low-output, 17: 17433
irradiation facilities for DIORIT and SAPHIR, 17: 16754
physics measurements in ZED-2, 17: 17402 (AECL-1684)
transfer of Jason, from Langley to Greenwich, 17: 17602
RESERPINE
protective effects of, against radiation in mice, 17: 15826
RESINS
radiation effects on petroleum-derived, 17: 16116(P)
radiation effects on polyester, with polyunsaturated polyester modifiers, 17: 16115(P)
radiation effects on polyester, with polyunsaturated polyalkenyl aryl modifiers, 17: 16118(P)
radiation effects on polyester, with polyunsaturated polyether modifiers, 17: 16119(P)
RESISTORS
design of high-voltage, 17: 16205(P)
RESPIRATORS
development, 17: 16332(R) (UCRL-7143)
development for protection against radioactive particulates, 17: 16314 (LADC-5343)
evaluation for protection against uranium compounds and highly toxic materials, 17: 16316 (LADC-5410)
RETICULO-ENDOTHELIAL SYSTEM
phagocytic capacity of, in man and dog, 17: 15571
phagocytic capacity in man with infections, 17: 15572
RHENIUM
helium ion fission, cross sections and mass yield curves for, 17: 17124 (TID-18131)
RHENIUM ALLOYS
Mo–Re, superconductive properties and technical applications of, 17: 16705
RHENIUM FLUORIDES
preparation and properties, 17: 15859(R) (ORNL-3397(p.112-13))
RHENIUM ISOTOPES
production of 2.8-hr half life, 17: 17242
RHENIUM ISOTOPES Re-182
positron decay of isomers, energies, and relative intensities of, 17: 17259
RHENIUM ISOTOPES Re-186
gamma spectra, 17: 17165
RHENIUM ISOTOPES Re-188
gamma spectra, 17: 17165
RHENIUM OXIDES

spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
RHODIUM
proton reactions (p,n) at 5 to 12 Mev, neutron spectra from, 17: 17293
RHODIUM ISOTOPES Rh-103
proton reactions (p,n) on, spectra from, 17: 17226
RHODIUM ISOTOPES Rh-105
gamma emission by, directional correlations of, 17: 17169
RIBONUCLEASE
radiation effects on activity in lymph cells, 17: 15690
RIBONUCLEIC ACID
protective effects of, against radiation damage to leukocytes in peripheral blood in rats, 17: 15692
protective effects of yeast, against radiation injury in human cells in tissue culture, 17: 15803 (SAM-TDR-62-85)
radiation effects on phosphorus-32 uptake by, in rat skin, 17: 15694
radiation effects on metabolism of, in rat liver, 17: 15798
RIBONUCLEIC ACID, DESOXY-
effects of injected, on nucleic acid metabolism of irradiated rats, 17: 15797
effects of injected, on ribonucleic acid metabolism in irradiated rats, 17: 15798
effects on incidence of chromosomal aberrations in irradiated and non-irradiated bone marrow, 17: 15788
localization of tritium-labeled of bacterial, use of electron microscopy and radioautography for, 17: 15596
phosphorus-32 decay in transforming, biological effects of, 17: 15599
radiation effects on spleen, whole-body exposure, 17: 15636(R) (TID-18061)
radiation effects on metabolism, whole-body exposure, 17: 15684
radiation effects on metabolism, whole-body exposure, 17: 15685
radiation effects on phosphorus-32 uptake by, in rat skin, 17: 15694
radiation effects on viscosity of single-stranded, in native state, 17: 15720
radiation effects on, mechanism of, 17: 15764
radiation effects on, in bacteriophages, 17: 15791
radiation effects on biological activity of, 17: 15792
radioinduced free radicals in solid-phase, 17: 15773
radiosensitivity of, effects of oxygen and sulfhydryl compounds on, 17: 15795
synthesis after irradiation, effects of pyrimidine precursors on, 17: 15782
RIBONUCLEOTIDES, DESOXY-
radiation effects on content of, in animal tissues, 17: 15789
ROCKET MOTOR NOZZLES
heat transfer in, 17: 17606 (NASA-TN-D-1578)
performance optimization of, evaluation of, for nuclear rockets, 17: 17606 (NASA-TN-D-1578)
ROCKET MOTORS
development of cesium ion, 17: 17604(R) (N62-11122)
ROCKET REACTORS
analysis of, analytical and experimental procedures used in, 17: 17609
load factors for, 17: 17603 (JPL-TR-32-233)
ROCKET REACTORS (KIWI)
testing of, in Project Rover, computer system for processing data from, 17: 16504 (LAMS-2845)
ROCKET REACTORS (TORY)
instrumentation design for Tory II-C, 17: 16881
ROCKETS
development, 17: 16195
nuclear, measurement problems in environment of, 17: 16384 (LADC-5679)
ROCKS
potassium isotope abundances in, variations, 17: 16270
rare earth content in earth's, 17: 16277
RODS
stress distributions in rapidly heated, transient, 17: 16260 (HE-150-210)
ROOTS
radiation effects from incorporated tritium on growth and development, 17: 15653
radiosensitivity of *Vicia faba*, 17: 15728
strontium uptake by, in *Zea mays*, 17: 15610
RUBIDIUM
content of, in bone, muscles, and soft tissues in man, 17: 15603
corrosive effects on metals at 1000 to 2000°F, 17: 16634 (AGN-8063)
solvent properties for metals at 1000 to 2000°F, 17: 16634 (AGN-8063)
thermodynamic properties up to 2000°F, determination of thermodynamic, 17: 16768(R) (AGN-8075)
RUBIDIUM CHLORIDE CRYSTALS
radioinduced color centers in, effects of dose and temperature on, 17: 16759
spectra of, ratio of K-band absorption to F-band absorption in, 17: 15942(R) (ARF-1184-8)
KCl–RbCl, radioinduced color centers in mixed, 17: 16759
RbCl–KBr, radioinduced color centers in mixed, 17: 16759
RUBIDIUM IONS
scattering by molybdenum target, energies of, 17: 17257
RUTHENIUM
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
volatility in waste calcination processes, effects of magnesium and sugar on, 17: 17615(R) (HW-76262)
volatility in wastes, effects of hypophosphite and phosphite on, 17: 17618 (ORNL-TM-263)
RUTHENIUM ALLOYS
Ru–V, crystal structure of intermetallic compounds and saturated solid solutions in, 17: 16717
RUTHENIUM ISOTOPES Ru-103
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
RUTHENIUM ISOTOPES Ru-105
beta decay scheme, 17: 17169
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
RUTHENIUM ISOTOPES Ru-106
distribution in soil from weapons tests, 17: 16288
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
RUTHENIUM OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970

S

SAFETY
in shipping reactor fuel elements, 17: 16317 (NAA-SR-Memo-8151)
research programs on, at ORNL, July to December 1962, 17: 16321(R) (ORNL-3401)
SAFETY HAZARDS
of radioactive luminous materials, 17: 16338
SALICYLIC ACID
protective effects against radiation, metabolic factors in, 17: 15794
SALIVA
radiation effects on sodium content, 17: 15719
SALTS
dissolution in underground domes, formation of spherical cavities by, 17: 16179(R) (TID-18074)
SAMARIUM
content of, in marine organisms, 17: 15604
determination of, in lanthanum oxide, spectrographic, 17: 15932
separation of, from rare earth concentrates by solvent extraction using amalgams, 17: 16157
SAMARIUM ALLOYS
Ag–Sm, crystal structure, 17: 16658 (TID-18197)
Au–Sm, crystal structure, 17: 16658 (TID-18197)
SAMARIUM BORIDES
electric conductivity of hexa-, 17: 16726
SAMARIUM CARBONATES
preparation by precipitation, 17: 15951 (LADC-5579)
preparation, properties, and structure, 17: 15950 (LADC-5566)
thermal decomposition of, compound formations in, 17: 15951 (LADC-5579)
SAMARIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
SAMARIUM FLUORIDES

preparation, properties, and structure, 17: 15950 (LADC-5566)
SAMARIUM ISOTOPES Sm-148
energy level de-excitation characters for, experimental 1^-, 17: 17201
SAMARIUM ISOTOPES Sm-152
energy level de-excitation characters for, experimental 1^-, 17: 17201
SAMARIUM OXIDES
radiation and temperature effects on mechanical and physical properties of, 17: 16760
SAMARIUM SULFATES
preparation, properties, and structure, 17: 15950 (LADC-5566)
SAMPLING
of the stratosphere, design of electrostatic precipitator for, 17: 16319(R) (NYO-9674)
of the upper atmosphere, design of apparatus for, 17: 16320(R) (NYO-9675)
SANDS
phosphorus-32 uptake by, in water basin, 17: 15622
SAP (SINTERED ALUMINUM PRODUCTS)
creep tests, 17: 17546(R) (SRO-80)
SARCOMAS
development of abdominal, in man 20 years after thorotrast application, 17: 15711
pathological effects of radium dial paints on, epidemiological follow-up of, 17: 16342
SATELLITES
description of Orbital Solar Observatory, 17: 16471
development and properties of, review, 17: 17610
effects of artificial, on ionosphere and interplanetary media, 17: 16863
materials for, optical and infrared properties of, 17: 15953 (NASA-TN-D-1523)
propulsion of, comparison of solar-thermal and solar-electric-thermal, 17: 16196
radiation effects on electric components of, electron, 17: 16875
SAVANNAH RIVER COMPONENTS TEST REACTOR
hazards evaluation of, 17: 17592 (DP-600)
operation, 17: 17546(R) (SRO-80)
SCANDIUM
content of, in marine organisms, 17: 15604
determination in coal ash, chromatographic and colorimetric, 17: 15920
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
preparation and magnetic properties, 17: 16723
separation of, from uranium ore leach, spectrographic, 17: 16164
separation of, from thorium using *M*-nitrobenzoic, quinoline-2-carboxylic, or tetrachlorophthalic acids, 17: 15909
SCANDIUM ISOTOPES Sc-42
decay schemes, 17: 17218
SCATTERING
amplitudes, asymptotic forms of Regge, 17: 17046
amplitudes for, analyticity domain of, 17: 16956 (NYO-10239)
amplitudes for arbitrary-spin, construction of invariant, 17: 17035
amplitudes of inelastic, 17: 16949 (JINR-E-1156)
amplitudes of, modified Regge formula for, 17: 17033
analyticity and unitarity conditions in, consequences of, 17: 16955 (NYO-10238)
angular momentum plane in high-energy, singularities in, 17: 17021
collision lifetimes in many-body processes, 17: 17030
Coulomb, decay of ultrahigh-energy particles in condensed matter as as result of, 17: 17056
coupling constant and spectral functions for high-energy, conformal mapping for, 17: 17054
Dirac equation with Yukawa potential for, 17: 16990
electrons on atoms, velocity dependence of total cross section for, 17: 17269
expressions for 3-j symbols, 17: 16957 (ORNL-TM-514)
first-order approximations for central potential, equivalence of Brysk and determinantal methods for, 17: 17011
frequency redistribution of, from moving atoms, 17: 16973
hard-core potential, Regge poles for, 17: 16992
inelastic, excitation of collective states of nuclei by proton, 17: 17276
multiple method of second difference sums in nuclear emulsions, 17: 16815
propagation of single-scattering distribution in multiple, 17: 17228
quasi-classical treatment of elastic, for heavy ions, 17: 17115 (JINR-P-1153)
recurrence relations for Appell functions in, calculation of matrix elements in angular momentum representation, 17: 16962
S matrix for high angular momentum, asymptotic behavior of, 17: 17023
single-channel, improved minimum principle for, 17: 17029
singularities of *s*-matrix after a canonical transformation, 17: 16978
theory of, crossing symmetry in S-matrix, 17: 17034
theory of, optical-model representation of, 17: 17067
trajectories of Regge poles from Yukawa potential, weak coupling case of, 17: 17277
SCINTILLATION
pulse forms in radioinduced, method of determining, 17: 16421 (CEA-2194)
SCINTILLATION DETECTORS
calibration for measuring radon-222 in air, 17: 16417 (AERE-R-4165)
description of neutron, for use above the atmosphere, 17: 16922
design and performance of, for beta counting, 17: 16430 (TRG-Report-464)
design and performance of, for space uses, 17: 16892
design, for cosmic particle detection in space, 17: 16893
design for dose and dose-rate indicators, 17: 16473(P)
design for monitoring airborne alpha activity, 17: 16476(P)
design of, for beta measurement in fluids, 17: 16482(P)
performance for low-level beta radiation, effects of sample-holder material on, 17: 16458
properties of Plexiglas, for use in, 17: 16418 (BNL-6865)
pulse forms of scintillations of fluorescent liquids in, method of determining, 17: 16421 (CEA-2194)
use of, for detection of pericardial effusion of heart, 17: 15582
use of liquid, for simultaneous carbon-14–tritium counting, 17: 16457
SEA WATER
radioactivity of, measurements in Federal Republic of Germany, April to June 1962, 17: 15625
SEALS AND GLANDS
design for concentric pair of ducts, 17: 16201(P)
design of double, with means for detecting leaks, 17: 16206(P)
design of, for EGCR core, 17: 17551 (TID-18099)
design of leading-in plate for passing cables into reactor vessels, 17: 17512(P)
design of plug for reactor standpipes, 17: 16211(P)
development of high-pressure pump seal, 17: 16183(R) (NYO-9801)
leak testing of seals on blister drive shafts for EGCR charge machine, 17: 16180 (TID-18233)
load-deflection and stress-deflection characteristics of metallic, photoelastic determination of, 17: 16170 (AECL-1662)
testing of, for use on EGCR charge machine blister drives, 17: 17427 (TID-18234)
SEDIMENTATION
radiation effects on sewage, 17: 16057(R) (TID-18262)
SEED
genetic effects of radiation in coffee, 17: 15565
radiation effects, genetic, 17: 15682
radiation effects on ascorbic acid content in *Vicia faba*, beta, 17: 15716
radioinduced free radicals in, effects of oil and protein content on, 17: 15763
radiosensitivity of chromosomes during germination, 17: 15650
radiosensitivity of, effects of moisture content on, 17: 15799
SEISMIC WAVES
amplitudes of, from nuclear explosions in four media, 17: 16286
generation by underground explosions, 17: 16287
propagation by nuclear explosions, 17: 16901
propagation from underground nuclear explosions, 17: 16905
SEISMOLOGY
detection and measurement of underground nuclear explosions, 17: 16262 (AD-297344)
earth motion from underground nuclear explosion, 17: 16265 (PNE-111F)
performance for detection of underground nuclear explosions, 17: 16905
SELENIUM
determination in sulfur, activation, 17: 15917
proton reactions (p,n) on, spectra from, 17: 17226

SELENIUM ISOTOPES Se-76
energy level lifetime, 0.559-Mev, 17: 17211
SELENIUM ISOTOPES Se-81
decay data, 17: 17298
SEMICONDUCTOR DETECTORS
design of oscillating-circuit type, 17: 16483(P)
development of, for airborne alpha particles, 17: 16332(R) (UCRL-7143)
development of highly linear, for space uses, 17: 16895
performance of silicon, in vacuum, 17: 16896
preparation of lithium-drifted, 17: 16898
properties of photoconductivity, for detecting single gamma photons, 17: 16451
radiation effects on silicon-junction, in space, 17: 16885
uses of, low-level, 17: 16056(R) (TID-18261(p.73-4))
SEMICONDUCTORS
development of, for direct energy conversion above 800°K, 17: 16775(R) (GACD-2813)
diffusion of lithium into, by drifting method, 17: 16898
preparation with controlled amounts of interstitial atoms and vacancies, 17: 16581(P)
radiation effects, 17: 16763
SEPARATION PROCESSES
development of foam, 17: 17619(R) (ORNL-TM-482)
SERINE
oxidation of tissue cells, 17: 15738
SERVOMECHANISMS
design for improved stowage, 17: 17480(P)
SEWAGE
cesium-137 content in treatment plant for, from fallout, 17: 16299
radiation effects on sedimentation of, 17: 16057(R) (TID-18262)
SHEEP
radiation injuries, correlation of systemic and hematological recovery, 17: 15804 (USNRDL-TR-606)
SHELLS
conference on simplified calculation methods, 17: 16192
stress analysis of thin spherical, 17: 16664 (UCRL-13064)
SHIELDED CONTAINERS
design for radioisotopes, 17: 16355(P)
design of 4-liter, for dissolver solutions, 17: 16194
SHIELDING
analysis of, for burst slug detection equipment for EGCR, 17: 17562 (TID-18241)
design of cubicle for, from patients with implanted radioisotopes, 17: 16345
design of, for EGCR service machine, 17: 17549 (TID-18097)
design of formable, for neutrons, 17: 16731(P)
electrostatic, for space vehicles, 17: 17395
performance and requirements in space vehicles, 17: 16876
requirements for manned space vehicles, 17: 16877
SHIELDING MATERIALS
radiation effects on organic-fluid, 17: 16107
SHIPPING
of irradiated reactor fuels, mechanics of, 17: 17450
procedures and regulations for spent fuel elements, 17: 16313(R) (EURAEC-292)
SHIPPINGPORT PRESSURIZED WATER REACTOR
coolant, radionuclide base levels for Core 1, Seed 3, 17: 17573 (WAPD-PWR-TE-128(Rev.))
coolant tritium content in, reduction of, by use of lithium-7 resin, 17: 17572 (WAPD-PWR-TE-103)
fuel elements, analysis of irradiated, 17: 17574 (WAPD-T-1461)
operation of, January 1963, 17: 17534(R) (DLCS-5000163)
SHOCK WAVES
propagation in quasi-neutral two-dimensional plasma, 17: 17377
properties, 17: 16776 (GAMD-2288)
SILICON
determination by x-ray spectrometry using electron-beam excitation, 17: 15908
determination in ocean-bottom cores by activation analysis, 17: 15886 (TID-18125)
determination of, in silicon-uranium systems, 17: 15892
krypton-85 ion reactions with, during glow discharge, 17: 16870
nuclear magnetic resonance in, ultrasonic determination of, 17: 16779 (ISS-62/17)
performance in semiconductor detectors, in vacuum, 17: 16896
radiation effects on solar cells of, in Van Allen belts, 17: 16884
radiation effects of electrons on carrier lifetime in, 17: 16736(R) (GA-3872)
radiation effects on, 0.01- to 1.8-Bev proton, 17: 16758
reactions with sodium beryllate solutions, 17: 16002
SILICON CARBIDE COATINGS
deposition on refractory bodies, method for, 17: 16628(P)
SILICON CARBIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
fabrication of thin-walled articles, 17: 16628(P)
SILICON ISOTOPES Si-28
bremsstrahlung reactions (γ,p) at 24 Mev, cross sections for, 17: 17155
interactions with alpha particles (α,γ), dependence upon resonance levels, 17: 16916
neutron reactions (n,α) at 13.4 and 13.8 Mev, energy spectrum, 17: 17145
SILICON ISOTOPES Si-29
neutron reactions (n,α) at 13.4 and 13.8 Mev, energy spectrum, 17: 17145
SILICON JUNCTIONS
radiation effects on, in space, 17: 16885
SILICON NITRIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
SILICON OXIDES
adsorption on thoria surfaces, infrared and kinetic studies of, 17: 16028
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
SILICON SYSTEMS
Cr–Mo–Si, oxidation resistance properties as coatings for niobium alloys, 17: 16633(R) (AD-296341)
Cr–Si–Ti, oxidation resistance properties as coating for niobium alloys, 17: 16633(R) (AD-296341)
Fe–Si, phase transition behavior of, impulsive loading effects on, 17: 16649 (LADC-5396)
Nb–Si–W, properties and structure of, 17: 16710
Pu–Si, preparation, 17: 16568
Si–U, analysis of, for silicon, 17: 15892
SILICOORGANIC COMPOUNDS
radiation effects on reactions between organosilicon hydrides and vinyl silicon compounds, 17: 16068
SILVER
conductivity and plastic behavior of whiskers of, under alpha irradiation, 17: 16762
determination in cadmium-containing materials by activation analysis, 17: 15912
determination in potassium nitrate-sodium nitrate systems, voltammetric, 17: 15853(R) (ORNL-3397(p.24-6))
diffusion of hydrogen in, studies of, by d(d,p)T reaction, 17: 17289
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
effects on gas absorption by thorium-containing getter, 17: 16620(P)
magnetoplasma resonance in, 17: 16841
proton fission at 140 Mev, cross sections, relative yields and mass distribution from, 17: 16053(R) (TID-18261(p.49-60))
proton reaction at 120 and 660 Mev, 17: 17149
proton reactions (p,n) on, spectra from, 17: 17226
separation from cadmium by electrolytic methods, 17: 15912
SILVER ALLOYS
Ag–Ho, crystal structure, 17: 16658 (TID-18197)
Ag–Sm, crystal structure, 17: 16658 (TID-18197)
Ag–Tb, crystal structure, 17: 16658 (TID-18197)
Ag–Tm, crystal structure, 17: 16658 (TID-18197)
Pu–Ag, preparation and properties, 17: 16556
SILVER COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
SILVER ISOTOPES Ag-107
reactions with carbon-12, compound nucleus formation cross sections for, 17: 17118 (JINR-P-1162)
SILVER ISOTOPES Ag-110
decay of isomer, beta, 17: 17251

SILVER ISOTOPES Ag-111
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
SILVER ISOTOPES Ag-113
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
SILVER OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
SINTERING
of oxides, review of lattice defects in, 17: 16534
SIOUX FALLS POWER REACTOR
control rod design and testing for, 17: 17531 (ACNP-63001)
development of, technical progress, July to September 1962, 17: 17529(R) (ACNP-62034)
SKELETON
calcium-47 and strontium-85 uptake by, in normal and rachitic rats, 17: 15591
SKIN
beryllium nitrate effects on guinea pigs, injected, 17: 15598
radiation effects on mitosis in rat, 17: 15694
radiation effects on phosphorus-32 uptake by DNA and RNA in rat, 17: 15694
radiation effects on, appearances of radiobiotropism in, 17: 15757
radioinduced erythema, effects of dose fractionation, 17: 15661
radioinduced tumors of, histology of, 17: 15806
radiosensitivity, effects of dose fractionation, 17: 15662
sorption of beta particles by, protective effects of adrenaline and tannin in rats against, 17: 15553
SKIN DISEASES
radiotherapy of, effectiveness of, 17: 16347
radiotherapy of, production of skin cancer by, 17: 16347
SKIN GRAFTING
genetic factors affecting take in mice, 17: 15585
immunological reactions in mice, 17: 15758
radiation effects on tolerance to, in mice, 17: 15760
radiosensitivity of response to allogenic and xenogenic, in rats, 17: 15646 (USNRDL-TR-619)
SLAGS
analysis of, for niobium and tantalum, x-ray spectrum, 17: 15900
SLUG CANS
corrosion of, during underwater storage, 17: 16598
SLUGS
bonding of uranium slug to aluminum can, 17: 16625(P)
SODIUM
analysis for oxide in liquid, apparatus for, 17: 16409(P)
analysis for oxygen, 17: 15878(R) (NDA-2154-5)
analysis for oxygen, continuous electrochemical analyzer for, 17: 15889(R) (UNC-5050)
carbon content of SRE, carburization potential of, 17: 17597 (NAA-SR-Memo-7804)
determination in ocean-bottom cores by activation analysis, 17: 15886 (TID-18125)
excretion in sweat, tracer study, 17: 15700
in gastric mucosa, effects on electric potential, 17: 15645 (USNRDL-TR-608)
neutron scattering by liquid, energy transfer in thermal, 17: 17183
pump design for liquid, 17: 16176 (NAA-SR-Memo-7955)
purification of reactor coolant, design and operation of equipment for, 17: 17436
radiation effects on excretion in saliva, 17: 15719
reduction of zirconium tetrachloride using, preparation of zirconium by, 17: 16615
technology of liquid, review, 17: 16535
SODIUM ACETATES
dissociation constant of alpha-deuterated-, potentiometric and spectrophotometric determination of, 17: 15990
SODIUM ACID CARBONATES
corrosive effects on stainless steel, 17: 16594(T,R) (EURAEC-29)
SODIUM ALLOYS
K–Na, magnetic field interactions with surface waves on, 17: 16784 (NASA-TR-R-161)
SODIUM BORATES
spectra in vapor, infrared, 17: 15945 (AROD-006.8)
vaporization phenomena of, mass-spectrometric study of, 17: 15944 (AROD-006.7)
SODIUM BROMIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
SODIUM CHLORATES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
SODIUM CHLORIDE CRYSTALS
luminescence spectra of europium-activated, 17: 16862
SODIUM CHLORIDES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
protective effects of physiological solutions of, against radiation, 17: 15846
radiosensitivity effects on red cell membranes, 17: 15787
SODIUM CHLORITES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
SODIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
SODIUM FLUORIDE CRYSTALS
positron annihilation in, theory of, 17: 17301
SODIUM FLUORIDES
radiation effects of neutrons on, nuclear magnetic resonance studies of, 17: 16111
SODIUM HALIDES
sodium-23 nuclear relaxation time in crystals of, 17: 16018
SODIUM HYDROXIDES
reactions with uranyl nitrate, conductometric studies, 17: 15999
SODIUM HYPOCHLORITES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
SODIUM IODIDES
sorptive properties of, for cadmium-115, indium, mercury, and zinc-65, 17: 15992
SODIUM ISOTOPES Na-22
production of, by 16-Mev cyclotron in Yugoslavia, 17: 17321
SODIUM ISOTOPES Na-23
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
nuclear relaxation time in sodium halide crystals, 17: 16018
SODIUM ISOTOPES Na-24
formation cross sections in proton reactions, 17: 17149
gamma spectra, 17: 16438
SODIUM NITRITES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
SODIUM OXIDES
BeO/Na_2O, effects of calcium, silicon, and strontium in, 17: 16002
SODIUM PERCHLORATES
protective effects of, against radiation inactivation of taka-amylase, 17: 15592
SODIUM PHOSPHATES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
SODIUM REACTOR EXPERIMENT
operation of, carburizing potential relation to temperature limitations for, 17: 17597 (NAA-SR-Memo-7804)
SODIUM SULFATES
radiation effects on phase transformations in, 17: 16066
SODIUM THIOSULFATES
protective effects against x radiation in animal cells, 17: 15769
SODIUM TUNGSTATES
radiation effects on phase transformations in, 17: 16066
SODIUM URANATES
precipitation, conductometric studies, 17: 15999
structural properties for uranyl bonding, 17: 15959 (TID-18140)
SOILS
isotopic exchange in soil-solution systems, 17: 15581
plant uptake of strontium isotopes, effects of mineral fertilizers, 17: 15613

radioactivity of, measurements in Federal Republic of Germany, January to March 1962, 17: 15624
radioactivity of, measurements in Federal Republic of Germany, April to June 1962, 17: 15625
sterilization with methyl bromide, effects on uptake of iodine-131 by pine trees, 17: 15735
SOLAR BATTERIES
radiation effects on silicon, in Van Allen belts, 17: 16884
radiation effects on silicon, 17: 16736(R) (GA-3872)
SOLAR FLARES
cosmic ray spectra from, 17: 16927
shielding of manned space vehicles from, 17: 16877
SOLAR RADIATION
cosmic primary energy spectrum during maximum, 17: 16932
geomagnetic field compression by, 17: 16282
monitoring of, instruments for, 17: 16471
properties, 17: 16939
radio-frequency, 5-year catalog of type II and type IV, 17: 16912
SOLID PROPELLANTS
radiation effects, 17: 16108
SOLID SOLUTIONS
metallic, methods for prediction of, 17: 16518 (LADC-5380)
SOLIDS
atom bombardment of binary, with square planar lattice, IBM 7090 program for describing, 17: 16778 (GEMP-192)
coding for self-organization, feasibility of, 17: 16506 (SCTM-251-62(24))
electron ejection and trapping in molecular, 17: 16751
thermal conductivity measurement of anisotropic, at high temperatures, 17: 16678
SOLVENT EXTRACTION PROCESSES
development for reactor fuels, review, 17: 17451
equipment for, in treating irradiated fuels, 17: 16140 (DP-757)
mathematical analysis, 17: 16165
SOVIET UNION
ages estimation of upper paleolithic period in region adjoining Dniester River by radiocarbon dating, 17: 16273
corrosion research in, observation of, 17: 16592 (TID-17940)
fallout monitoring in Leningrad area of, 1958–60, 17: 16304
SPACE
atomic reactions in, 17: 16886
book: *Space Science and Technology. Volume 4*, 17: 17610
charged particle distributions in, development of detectors for, 17: 16895
cosmic radiation measurement in, telemetry systems for, 17: 16879
disturbances in, due to fast moving artificial satellites, 17: 16863
electromagnetic-signal propagation through, distortion effects, 17: 16890
electron and proton distributions in, measurements of, 17: 16893
materials for, techniques and results obtained from study of, 17: 16724
polarization of interstellar, by graphite flakes, 17: 16915
properties of, conference, 17: 16874
solar wind velocity in, consequences of nonuniformity, 17: 16913
SPACE FLIGHT
biological effects of radiation in, 17: 16341
feasibility of interstellar, 17: 17603 (JPL-TR-32-233)
shielding requirements for manned, 17: 16877
uses for analyzing space phenomena, conference, 17: 16874
SPACE VEHICLES
auxiliary power units, disposal of nuclear at re-entry, 17: 16310 (AFSWC-TDR-62-83)
design of manned nuclear, 17: 17613
development, landing, and propulsion of, review, 17: 17610
materials for, techniques and results obtained from study of, 17: 16724
nuclear power uses in, heat rejection problems for, 17: 16230(R) (PWA-16230)
propulsion of, radioisotope systems for, 17: 17611
propulsion of, study of ion guns for, 17: 17605(R) (N62-11311)
propulsion, performance of thermonuclear systems for, 17: 16891
propulsion stage design, influences of nuclear engine on, 17: 17612
propulsion systems for, research on, 17: 16195
radiation-detector designs for, 17: 16892
radiation effects of Van-Allen neutrons and protons on, 17: 16876
shielding for, electrostatic, 17: 17395
shielding from solar flares and Van-Allen protons, 17: 16877
thermal radiation from shock layers of, in re-entry, 17: 15539
SPARK DETECTORS
design of, for detection of neutrons, 17: 16484(P)
development of, with ferrite core memories, 17: 16427 (PPAD-461E)
SPECIFIC HEAT
determination at low temperatures, use of helium-3 temperature scale for, 17: 15952 (LADC-5711)
SPECTROPHOTOMETERS
development, 17: 15854(R) (ORNL-3397(p.26-38))
development of direct-reading, 17: 15851(R) (ORNL-3397(p.1-16))
SPECTROSCOPY
copper-spark method in, 17: 15934
SPERM
radiation effects on chromosomes, 17: 15637(R) (TID-18135)
radiation effects on nucleic acid content, vitality, and fecundating ability, 17: 15689
SPERMATOGENESIS
cesium-137 effects on rat, 17: 15704
radiosensitivity in mice, 17: 15637(R) (TID-18135)
SPHERES
transient effects of magnetic field penetration into superconducting, 17: 16816
SPLEEN
effects on radiation resistance of animals, 17: 15754
gold-198 distribution in, after intracardiac injections in rats, 17: 15607
histology, effects of extracorporeal irradiation of blood, 17: 15639(R) (TID-18194)
protective effects of injections or removal of, against whole-body irradiation in mice, 17: 15811
protective effects of dialized and whole homogenates of, against lethal radiation in mice, 17: 15812
protective effects of, with bone marrow cells against lethal radiation in mice, 17: 15814
protective effects of, against lethal radiation in dogs, technique for preparation of suspensions for, 17: 15845
radiation damage of lymphoid centers, effects of thymus on recovery from, 17: 15752
radiation effects on desoxyribonucleic acid, whole-body exposure, 17: 15636(R) (TID-18061)
radiation effects on desoxyribonucleoprotein in, in mice, 17: 15706
radiation effects on methionine synthesis in rabbit, 17: 15843
radioactive contamination of human, from fallout, 17: 16346
SQUALENE
metabolic effects, 17: 16360(R) (NP-12597)
STAINLESS STEEL
analysis and fabrication of, 17: 16594(T,R) (EURAEC-29)
analysis of neutron-irradiated, for radionuclides, 17: 15858(R) (ORNL-3397(p.17-112))
bonding by gas pressure, 17: 15532(R) (BMI-1607(Del.))
corrosion at 25 and 250°C in oxygen and water, microgravimetric measurement of, 17: 16585(R) (EURAEC-569)
corrosion by sulfuric acid and sodium bicarbonate solutions, 17: 16594(T,R) (EURAEC-29)
corrosion of, bibliography on, 17: 16593 (VDIT-5a)
corrosion of, by steam at 1050°F, 17: 16587 (GEAP-4165)
corrosion of, by steam-water spray, 17: 17406(R) (EURAEC-519)
corrosion of, in high-temperature water and steam, surface state effects on, 17: 16595(T,R) (EURAEC-552)
creep-rupture properties of thin-wall tubes of type 316, 17: 16682
fabrication of high-quality tubing of, 17: 16603 (ANL-FGF-409)
fracture toughness, 17: 16640 (DMIC-Memo-164)
light emission from, at 50°C in 0.25 to 27 μ wavelength region, 17: 15953 (NASA-TN-D-1523)
mechanical properties of irradiated type 347, effects of 1000 and 1800°F annealing on, 17: 16733 (BMI-1621)
properties as claddings for uranium carbide fuels, 17: 16650 (NAA-SR-7696)
radiation and temperature effects on mechanical and physical properties of, 17: 16760
reactions with water at high temperatures, 17: 17447
Eu_2O_3–SS, corrosion by water, 17: 17446
STAINLESS STEEL COUPLES

Al/stainless steel, corrosion, 17: 16584(R) (EURAEC-550)
STANFORD LINEAR ACCELERATOR
design and fabrication of accelerating structure, 17: 17316 (SLAC-7)
development, 17: 17317(R) (SLAC-8)
shielding for, transverse radiation, 17: 17318 (SLAC-9)
STARCHES
radiation effects on 2.5% solution of, 17: 16087
STARK EFFECT
radial field distribution measurement in Penning discharge by, 17: 16804
STARS
neon-20 production in supernova, 17: 16916
STATISTICS
book: *Lectures on the Many-Body Problem*, 17: 17060
errors in measurement of nuclear radiation pulses, 17: 16449
functional integrals in, 17: 17066
Green's function in many-body, 17: 17069
interacting systems in, description of weakly, strongly, or completely correlated, 17: 16799
methods in neutron physics, 17: 17471
quantum, for negative-energy bosons and fermions, 17: 16998
strange particles and para-, 17: 17001
STEAM
separation from water by gravity, carry-under studies, 17: 16240
steam-water, two-phase critical flow in annuli, 17: 16239
STEEL
corrosion in oxygen-containing aqueous media, 17: 16599
corrosion resistance in acid medium, 17: 16597
fabrication of, welding techniques in, 17: 16611(T,R) (EURAEC-551)
mechanical properties of reactor, effects of post-irradiation heat treatment on, 17: 16752
phase transformation of low carbon austenite 18-10 to martensite during cold working at very low temperatures, 17: 16531
phase transformations in, method for determining temperature of ductile-brittle, 17: 16644(R) (EURAEC-561)
radiation and temperature effects on mechanical and physical properties of low-alloy, 17: 16760
radiation effects on U-8, 17: 16541
radiation effects on brittle-rupture properties of, survey of, 17: 16743 (TID-17682)
reactions with water at high temperatures, survey of mechanism, 17: 16601
thermal expansion, x-ray studies, 17: 16667
welding of reactor, techniques for, 17: 16616
STELLARATORS
plasma magnetic compression heating in, 17: 17326 (MATT-133)
STOMACH
sodium effect on electric potential in mucosa, 17: 15645 (USNRDL-TR-608)
STRANGE PARTICLES
decay of, forbidden multimeson configurations in, 17: 16952 (JINR-P-1161)
interactions of, formal theory for, 17: 17079
parastatistics of, 17: 17001
STRATOSPHERE
monitoring, 17: 16320(R) (NYO-9675)
sampling, design of electrostatic precipitator for, 17: 16319(R) (NYO-9674)
STREPTOMYCIN
protective effects of, against radiation, 17: 15846
STRESS ANALYSIS
computer program for, 17: 16173 (KAPL-M-JVM-4)
deflections and stresses of thin spherical shells during bending, measurement and theory of, 17: 16664 (UCRL-13064)
determination of transient stress distribution in rods, effects of rapid internal heat generation on, 17: 16260 (HE-150-210)
STRONTIUM
adsorption by Linde 4A zeolite, effects of flow, particle size, and temperature on, 17: 17615(R) (HW-76262)
Auger spectrum, 17: 16810
content of, in components of Canadian diet, 17: 15587 (CRER-1068)
distribution of foliar-applied, in corn and soybean plants, tracer study, 17: 15590(R) (TID-18161)
precipitation from solutions containing cations, use of dilituric acid in, 17: 16055(R) (TID-18261(p.71-2))
reactions with sodium beryllate solutions, 17: 16002
solvent extraction from Purex FTW, flowsheet development for, 17: 17615(R) (HW-76262)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
uptake by roots of *Zea mays*, 17: 15610
STRONTIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
STRONTIUM FLUORIDE CRYSTALS
spectra of divalent samarium containing, Zeeman effect in absorption and luminescence, 17: 16011(T)
spectra of divalent samarium containing, deformation splitting of lines in, 17: 16012(T)
STRONTIUM ISOTOPES
plant uptake from soils, effect of mineral fertilizers, 17: 15613
STRONTIUM ISOTOPES Sr-85
decay and half life, 17: 17298
uptake of, by skeleton in normal and rachitic rats, 17: 15591
STRONTIUM ISOTOPES Sr-88
mass difference from zirconium-90, 17: 17158
STRONTIUM ISOTOPES Sr-89
decay and half life, 17: 17298
half life of, search for isomers in measurements of, 17: 17243
STRONTIUM ISOTOPES Sr-90
biological effects of injected, on swine bone, 17: 15847
content in body, measurements of, in Federal Republic of Germany, January to March 1962, 17: 15624
content in Norwegian milk during 1961, 17: 15614 (A/AC.82/G/L.810)
content of, in "hot zones" in human skeletos, 17: 15606
distribution in soil from weapons tests, 17: 16288
removal from animals, effects of triethylenetriamine hexaacetic acid, 17: 15589(R) (TID-18058)
toxic effects in sheep, 17: 15541(R) (ORO-598)
uptake by *Gammarus lacustris*, 17: 15623
uptake by hair after injection into rats, 17: 15612
STRONTIUM ISOTOPES Sr-91
half life of, search for isomers in measurements of, 17: 17243
STRONTIUM NITRATES
reactions of, with dinitrogen tetroxide and spectra of anhydrous, 17: 15995
STRONTIUM SULFATES
reactions with cristobalite, 17: 15986
STRONTIUM TITANATES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
fabrication by vibratory compaction, 17: 16609(R) (NYO-10214)
STRUCTURAL COLUMNS
stress analysis of, computer program for, 17: 16173 (KAPL-M-JVM-4)
STRUCTURES
humidity measurements at sites of, using neutron sources, 17: 15903
STYRENE POLYMERS
electron energy loss in films of, 17: 15765
radiation effects on phosphors in, 17: 16077
triton ranges and stopping cross sections in, 17: 17212
SULFAMIC ACID
solvent properties for plutonium, 17: 15957 (TID-16387)
HNO_3–NH_2SO_3H, solvent properties for plutonium, 17: 15957 (TID-16387)
SULFANILAMIDE
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668
SULFEX PROCESS
construction materials for, corrosion behavior of, 17: 17451
SULFOXIDES
effects of methionine sulfoximine on distribution of potassium in rat tissues, tracer study, 17: 15687
SULFUR
analysis for selenium, activation, 17: 15917
spectra of, high energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-

20)
SULFUR COMPOUNDS
analysis for selenium, activation, 17: 15917
SULFUR ISOTOPES S-32
bremsstrahlung reactions (γ,p) at 24 Mev, cross sections for, 17: 17155
interactions with alpha particles (α,γ), dependence upon resonance levels, 17: 16916
SULFURIC ACID
chemical effects on separation of uranium from irradiated fuels, 17: 16145 (ORNL-3312)
corrosive effects on stainless steel, 17: 16594(T,R) (EURAEC-29)
SUN
corona of, erroneous physical interpretations in hydrodynamic model of, 17: 16914
wind velocity from, consequences of nonuniform, 17: 16913
SUPERCONDUCTIVITY
theory, 17: 17076
transition temperatures in films, in contact with superconducting films, 17: 16830
uses in travelling-wave plasma accelerators, 17: 16771(R) (ASD-TDR-62-1105)
SUPERCONDUCTORS
Abrikonov vortex lines in hard, driving force acting on, 17: 16805
critical currents in Nb_3Sn, 17: 16805
development at ORNL for magnets, 17: 17336(R) (ORNL-3392(p.66-85))
dielectric properties of, 17: 16840
magnetic properties of films of, quantum effects in, 17: 16838
magnetic, pump for flux accumulation in, 17: 16174 (LADC-5418)
properties of, in intermediate state, effect of imperfections on, 17: 16871
properties of niobium–zirconium alloys at 9,250 Mcps, 17: 16722
ultrasonic shear wave attenuation in tin, 17: 16729
SUPERHEATERS (NUCLEAR)
design of pressurized, for boiling reactor, 17: 17536 (GEAP-4057)
SUPERSONIC FLOW
magnetohydrodynamics of, 17: 16855
SURFACE FRICTION
for turbulent boundary-layer flow longitudinal to circular cylinder, 17: 16242
SURFACE WATERS
fallout deposition and removal in drainage area of Vistula River, 17: 15617
radioactivity of, measurements in Federal Republic of Germany, January to March 1962, 17: 15624
radioactivity of, measurements in Federal Republic of Germany, April to June 1962, 17: 15625
SURFACES
analysis of lunar, instrumentation for radiometric, 17: 16894
SWIMMING POOL REACTORS
irradiation facility design and operation in SAPHIR, 17: 16074
neutron spectral distribution in core and reflector, 17: 17600(T) (CEA-tr-A-1194)
reactivity of, effects of small fuel displacements on, 17: 16322(R) (ORNL-3401(p.3-4))
SWINE
radiation effects of plutonium-239, radium-226, and strontium-90 injected intravenously, 17: 15847
radiation injuries, pathology, 17: 15541(R) (ORO-598)
radiosensitivity of skin, effects of dose fractionation, 17: 15662
SWITCHES
development of transistorized, for reactor instrumentation, 17: 17411(R) (GEMP-177C)
survey of, for Stanford linear accelerators, 17: 17317(R) (SLAC-8)
use of tunnel diodes in fast discriminating, 17: 16382 (IDO-16823)
SYNCHROTRONS
particle orbits in, effects of slow rotation of median plane on, 17: 17313 (LNF-62/95)
SYSTEMS FOR NUCLEAR AUXILIARY POWER
dynamic behavior of, bibliography on, 17: 17420 (NAA-SR-7786)
four group cross sections for SNAP 2 and 8 cores, 17: 17422 (NAA-SR-Memo-7789)
reliability and safety of radioisotopic, 17: 17607
review, 17: 16190
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-2)
boiler evaluation for, 17: 16227 (NAA-SR-Memo-7945)
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-7)
engineering drawings, 17: 16193
SYSTEMS FOR NUCLEAR AUXILIARY POWER (SNAP-10)
re-entry destructive burnup, evaluation of, 17: 16310 (AFSWC-TDR-62-83)

T

TANNINS
protective effects of, against skin absorption of beta particles by rats, 17: 15553
TANTALUM
alloying effects on titanium, 17: 16580(P)
analysis for niobium, buffer effects in spectrochemical, 17: 15899
argon-ion reactions on, secondary from, 17: 16836
casting, melting, and properties of, 17: 16532
corrosion of, by rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
determination in niobium oxide–tantalum oxide mixtures, spectrographic, 17: 15857(R) (ORNL-3397(p.57-70))
determination in niobium, buffer effects in spectrochemical, 17: 15899
determination of, effects of phosphomolybdate on spectrographic, 17: 15930
determination of, in alloys, ores, and slags, x-ray spectrum, 17: 15900
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
melting effects on work hardening properties of, electron beam and inert gas arc, 17: 16712
production by reduction of pentachloride using hydrogen, 17: 16548
production of, electrolytic, 17: 16547
properties and uses of, mechanical and physical, 17: 16715
properties for exothermic brazing, 17: 16608(R) (NP-12615)
proton reactions (p,n) at 5 to 12 Mev, neutron spectra from, 17: 17293
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
TANTALUM ALLOYS
Nb–Ta–W, mechanical properties at 2600°F of coated, evaluation of, 17: 16633(R) (AD-296341)
TANTALUM CARBIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
TANTALUM CHLORIDES
reduction using hydrogen, 17: 16548
TANTALUM FILMS
oxygen adsorption by, measurement of, by resistance measurements, 17: 16719
TANTALUM ISOTOPES Ta-181
electron inelastic scattering by, 17: 17233
photoneutron cross sections of, 17: 17227
TANTALUM NITRIDES
emissivity, measurement of spectral, 17: 16632(R) (AD-274654)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
TANTALUM OXIDE FILMS
stresses in, measurements of, 17: 16685
TANTALUM OXIDES
NbO–TaO, analysis for niobium and tantalum, 17: 15857(R) (ORNL-3397(p.57-70))
Nb_2O_5–Ta_2O_5, chlorination in ore concentrates, 17: 16024
Nb_2O_5–Ta_2O_5, electrolytic reduction of, 17: 16547
TANTALUM SYSTEMS
C–Nb–Ta–V–Zr, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
TAURINE
radiation effects on excretion and plasma levels of, in cancer patients, 17: 15784
TBP PROCESS
developments in, 17: 16146 (ORNL-TM-527)
TEETH
pathological effects of radium dial paints on, epidemiological follow-up of, 17: 16342
TEKTITES
rare earth content, 17: 16305
TELEMETERING SYSTEMS
design of f-m, 17: 17334(R) (ORNL-3392(p.49-55))

TELLURIUM
preparation of aerosol of, 17: 15939 (AERE-M-1130)
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
TELLURIUM ISOTOPES Te-127
isomeric states, 17: 16049(R) (TID-18261(p.19-23))
TELLURIUM ISOTOPES Te-128
carbon-12 reactions with, isomeric cross section ratios for neutron-transfer, 17: 16050(R) (TID-18261(p.24-6))
carbon-12 reactions (C^{12},3n), cerium-137 isomeric cross section ratio from, 17: 16054(R) (TID-18261(p.61-70))
proton reactions (p,pn) with, isomeric cross section ratios for, 17: 16049(R) (TID-18261(p.19-23))
TELLURIUM ISOTOPES Te-129
isomeric states, 17: 16049(R) (TID-18261(p.19-23))
TELLURIUM ISOTOPES Te-130
proton reactions (p,pn) with, isomeric cross section ratios for, 17: 16049(R) (TID-18261(p.19-23))
TELLURIUM OXIDES
separation of tellurium aerosols from heated, 17: 15939 (AERE-M-1130)
TELLURIUM SYSTEMS
solid-state properties of, bibliography on, 17: 16655 (SB-62-62)
Cr–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Nb–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Sb–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Te–Sn–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
TEMPERATURE
effects of 0–5°C, on blood in rats, 17: 15796
effects on radioinduced graft polymerization, 17: 16041(R) (NCSC-2477-10)
generation of very high, apparatus for, 17: 17391(P)
measurement of changes in dielectric constant, 17: 17411(R) (GEMP-177C)
radiosensitivity effects on enzymes, 17: 15780
radiosensitivity effects, 17: 15794
radiosensitivity effects on blood of rats, 17: 15796
TERBIUM
content of, in marine organisms, 17: 15604
separation from lanthanum, 17: 16149(T) (CEA-tr-A-1230)
TERBIUM ALLOYS
Ag–Tb, crystal structure, 17: 16658 (TID-18197)
Au–Tb, crystal structure, 17: 16658 (TID-18197)
TERBIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
TERBIUM ISOTOPES Tb-159
proton fission at 80-Mev, relative yields from, 17: 16052(R) (TID-18261(p.44-8))
TERBIUM OXIDES
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
TERPHENYL
analysis for iron by x-ray emission spectroscopy, 17: 15897
heat transfer properties of, effects of dissolved nitrogen on, 17: 16228 (NAA-SR-Memo-8064)
molecular structure, theory of carbon-carbon bonds in, 17: 16031(R) (TID-17275)
TESTOSTERONE
sensitizing effects of, against radiation in buccal cells in rabbits, 17: 15666
TEXTILES
radiation effects, 17: 16104
radioinduced graft polymerization of, fiber property modifications by, 17: 16041(R) (NCSC-2477-10)
THALLIUM
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
spectra of, spin-orbit coupling in band structure, 17: 16845
THALLIUM ALLOYS
Pu–Tl, preparation, 17: 16568
THALLIUM CHLORIDES
chlorine-36 exchange from, to nitrosyl and phosphoryl chlorides, 17: 15996
THALLIUM COMPLEXES
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
THALLIUM ISOTOPES Tl-207
separation from other naturally occurring radioisotopes by ion exchange using ammonium molybdatophosphate, 17: 16159
THALLIUM ISOTOPES Tl-208
separation from other naturally occurring radioisotopes by ion exchange using ammonium molybdatophosphate, 17: 16159
THERMAL CONDUCTIVITY
measurement at high temperature, pulse method for, 17: 16226 (LADC-5310)
measurement in crystals, effects of atomic admixtures on, 17: 15967(T) (SCL-T-468)
THERMAL NEUTRONS
capture by holmium-166, lutetium-176, and thulium-170, 17: 17181
capture gamma spectra comparison, 17: 17255
detection by boron-trifluoride-gas-filled ionization chamber, design and patent for, 17: 16481(P)
diffusion of, measurement of water content in building materials by, 17: 15902
scattering by iron(II) chloride near Neel temperature, cross section for small-angle, 17: 16006
scattering by sodium (liquid), energy transfer in, 17: 17183
spectra of, relation to scattering law, 17: 17088 (BNL-770)
thermalization in homogeneous systems, 17: 17465
transport equation for, asymptotic solutions of, 17: 17090 (GA-3298)
THERMAL RADIATION
detection and measurement, apparatus for, 17: 16488(P)
emission from shock layers from blunt bodies traveling at re-entry velocities, 17: 15539
from nuclear explosions, behavior of, 17: 16330 (P-1951(RAND))
transport of, thick-thin approximations for non-steady, 17: 16777 (GAMD-3095)
THERMAL REACTORS
development of, for fast-thermal systems to re-use fuels, 17: 17413(R) (HW-74549)
THERMIONIC CELLS
design of gas-filled nuclear, 17: 17586(P)
development, 17: 16790 (TID-18216)
electron and ion sources in, studies of monocapillary emitter as, 17: 16773(R) (EDR-3207)
emission constants of actinides in, 17: 16783 (LADC-5128)
fundamental processes in, research on, 17: 16769(R) (AI-7979)
THERMOCOUPLES
calibration of Alumel-Chromel-P, effects of CO–CO_2 environments on, 17: 16526 (ORNL-TM-481)
design of, for use in reactor piping systems for detection of particulate solids, 17: 16588 (HW-75626)
testing of three-wire, 17: 16237(T,R) (EURAEC-523)
THERMODYNAMIC PROPERTIES
of cesium and rubidium up to 2000°F, 17: 16768(R) (AGN-8075)
THERMODYNAMICS
interacting systems in, description of weakly, strongly, or completely correlated, 17: 16799
kinetic theory of nonequilibrium, 17: 16864
quantum field theory in, 17: 16806
stagnation point heat transfer in partially ionized diatomic gas, theory of, 17: 16251
stagnation point heat transfer in partially ionized air, 17: 16252
statistical mechanics at equilibrium, Debye, Boltzmann, and general methods for, 17: 17350
zero-temperature properties of many-fermion system, 17: 17031
THERMOELECTRIC CELLS
characteristics of space-charge, compensated by cesium plasma, 17: 16186
THERMOMAGNETIC CELLS
performance analysis of Nernst, 17: 16187
THERMONUCLEAR EXPLOSIONS
atmospheric effects of high-altitude, 17: 16297
atmospheric effects of high-altitude, 17: 16298
atmospheric gravity waves from, 17: 15538
effects of high-altitude, path length and amplitude of myriametric waves,

17: 16272
effects of ionization on radio wave propagation, 17: 15536
magneto-telluric effects of high-altitude, 17: 15537
THERMONUCLEAR REACTIONS
containment and stabilization, review of five most promising approaches, 17: 17378
research programs at ORNL, 17: 17329(R) (ORNL-3392)
use of, as energy source, 17: 17353
THERMONUCLEAR REACTORS
development at ORNL, 17: 17329(R) (ORNL-3392)
performance for space propulsion, 17: 16891
THERMONUCLEAR WEAPONS
fallout from, distribution in soil, 17: 16288
THICKNESS GAGES
design of beta, which is insensitive to atomic number, 17: 16397(P)
design of gamma-ray caliper for measuring wall thickness of insulated pipes carrying fluids, 17: 16411(P)
design of radiometric, using adjustable aperture, 17: 16399(P)
design of radiometric, using adjustable aperture, 17: 16400(P)
design of radiometric, using adjustable aperture, 17: 16401(P)
design of, using back-scattering of gamma rays and no shielding between source and detector, 17: 16407(P)
THIOPHENE
radiation stability, 17: 16063
THIOPHOSPHORIC ACID, ALKYL ESTERS
complex formation with metals, 17: 15858(R) (ORNL-3397(p.71-112))
THIOSULFATES
radiosensitivity effects on red cell membranes, 17: 15787
THORIUM
determination in aluminum, copper, and magnesium alloys, complexometric, 17: 15921
determination in granite, spectrophotometric, 17: 15861(R) (ORNL-3397 (p.117-21))
determination in ocean-bottom cores by radiation spectra analysis, 17: 15886 (TID-18125)
determination in uranium ores by ion exchange-spectrographic methods, 17: 15898
determination of, in presence of rare earths using dibromarsenazo II, 17: 15826
determination of, use of arsenaze III in colorimetric, 17: 15861(R) (ORNL-3397(p.117-21))
determination of, using Xylenol Orange, spectrophotometric, 17: 15910
development as reactor fuel, 17: 17444
electric conductivity of cold-worked, annealing recovery of, 17: 16651 (NAA-SR-Memo-1522)
fabrication of getters containing, 17: 16620(P)
neutron elastic low-angle scattering at 14.2 Mev, 17: 17097
precipitation of, with uranium peroxides, 17: 16079
separation from nitric acid solutions by solvent extraction using TBP and sodium fluoride solutions, 17: 16161
separation from nitric acid solutions by solvent extraction using TBP and fluorides, 17: 16162
separation from rare earths by solvent extraction, use of fluoride ions in, 17: 16163
separation of, from scandium using *M*-nitrobenzoic, quinoline-2-carboxylic, or tetrachlorophthalic acid, 17: 15909
structure, 17: 16559
synergistic effects on distribution coefficients of elements with ion-exchange resin from nitric acid, 17: 15948 (LA-2836)
THORIUM ALLOYS
properties of, research on, 17: 16527(R) (USBM-U-1001)
Pu–Th, phase diagram, 17: 16566
Pu–Th, phase diagram, 17: 16567
Pu–Th, preparation, 17: 16568
Pu–Th, radiation effects on, 17: 16572
THORIUM BORIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
THORIUM COMPLEXES
with 2-methyl-8-quinolinol and 8-quinolinol, structure of, 17: 16004
THORIUM COMPOUNDS
development as reactor breeder material, 17: 17444
THORIUM ISOTOPES Th-232
helium ion fission, cross sections and mass yield curves for, 17: 17124 (TID-18131)
neutron resonance capture rate of, analysis of activation measurements of, 17: 17107 (GA-3069)
neutron resonance integrals for, fast, 17: 17470
proton fission at 20 Bev, 17: 17180
THORIUM NITRATES
$Th(ONO_2)_4$–H_2O, infrared spectra following heating to 170°C, 17: 16028
THORIUM OXIDE POWDERS
particle size determination of, dye adsorption method for, 17: 15938 (AEET/CD/5)
THORIUM OXIDES
adsorption of silica on, infrared and kinetic studies of, 17: 16028
neutron resonance capture rate of, analysis of activation measurements of, 17: 17107 (GA-3069)
separation from rare earth ores, process for, 17: 16130(P)
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
glass–ThO_2, fabrication, 17: 17478(P)
THORIUM(IV) OXIDES
effects of arterial application of thorotrast on sarcoma development, 17: 15711
effects of, on liver, case study of late, 17: 15691
THORIUM PEROXIDES
precipitation of, with neptunium and plutonium, 17: 16079
THORIUM PHOSPHATES
properties of activated phosphors of, 17: 16684
THULIUM
content of, in marine organisms, 17: 15604
neutron capture in, gamma energies from thermal, 17: 17181
separation from lanthanum, 17: 16149(T) (CEA-tr-A-1230)
THULIUM ALLOYS
Ag–Tm, crystal structure, 17: 16658 (TID-18197)
Au–Tm, crystal structure, 17: 16658 (TID-18197)
THULIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001
THULIUM FERRATES
thulium-169 gamma spectra in, hyperfine structure of, 17: 17187
THULIUM ISOTOPES Tm-169
gamma spectra in thulium iron garnet, hyperfine structure of, 17: 17187
hyperfine transitions and magnetic and quadrupole moments of 8.42-kev state of, at 5 to 60°K, 17: 17252
THULIUM ISOTOPES Tm-170
gamma emission, 17: 17181
gamma spectra, 17: 17165
THULIUM ISOTOPES Tm-173
half life, 17: 17114 (JINR-P-1148)
THYMIDINE
metabolism by corneal cells, tracer study, 17: 15586
metabolism in plant cells, tracer study, 17: 15653
radiation effects on metabolism, tracer study, 17: 15684
radiation effects on metabolism, tracer study, 17: 15685
THYMINE
radiosensitivity effects on paramecia, 17: 15737
radiosensitivity effects of indole series on, in vitro and in vivo in mice, 17: 15842
THYMOLS
carbon-14 content in, annual variation, 17: 15618
THYMUS
effects on spleen lymphoid recovery after irradiation, 17: 15752
gold-198 distribution in, after intracardiac injections in rats, 17: 15607
immunologically reactive cells in, development, 17: 15644 (USNRDL-TR-605)
THYROID DISEASES
radiotherapy with iodine-131, effects on blood picture, 17: 15696
THYROID GLAND
diagnosis of disorders of, using iodine-131, review of, 17: 15550
iodine metabolism in infants, tracer study, 17: 15600
iodine uptake by, rate and turnover of, 17: 15605
pathology of, protective effects of iodine-132 and -133 in study of, 17: 15568

THYROID HORMONES
protective effects of, against radiation sickness, 17: 15673
TIMING CIRCUITS
design of delay, for analog computer, 17: 16503 (BLG-134)
TIN
alloying effects on titanium, 17: 16580(P)
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
determination of, in ores, x-ray spectrum, 17: 15900
magnetoplasma resonance in, 17: 16841
proton reactions at 120 and 660 Mev, yields from, 17: 17149
proton reactions (p,n) on, spectra from, 17: 17226
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
superconducting, attenuation of transverse ultrasonic waves in, 17: 16729
TIN ALLOYS
Al–Mo–Sn–Zr, properties as claddings for uranium carbide fuels, 17: 16650 (NAA-SR-7696)
Al–Nb–Sn, crystal structure and alloying properties, 17: 16727
Ge–Sn–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Nb_3Sn, critical currents in, 17: 16805
Nb–Sn, crystal structure, equilibrium solubilities, and constitutional diagram for, 17: 16727
Nb–Sn, superconductive properties and technical applications of, 17: 16705
TIN COMPOUNDS
triphenylchlorostannane, Mossbauer spectra of, 17: 16013
TIN IONS
radioinduced oxidation of stannous, 17: 16043(R) (TID-18094)
TIN OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
TIN SYSTEMS
Te–Sn–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
TISSUE CULTURES
radiation effects on oxidation reactions of, 17: 15738
radiation effects on HeLa cells in, from lutetium-177 and phosphorus-32, 17: 15707
radiation injury in human cells, protective effect of yeast ribonucleic acid, 17: 15803 (SAM-TDR-62-85)
TISSUE HOMOGENATES
radioinduced luminescence of liver, 17: 15736
TISSUES
analysis by emission spectrometry, 17: 15857(R) (ORNL-3397(p.57-70))
cesium, potassium, and rubidium content in soft, in man, 17: 15603
radiation effects on deoxyribonucleotide content of, 17: 15789
radiation sorption by soft, near bone, 17: 15702
radioinduced carbonyl compounds in animal, 17: 15631 (NP-12601)
TITANIUM
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
determination of trace quantities of, by neutron activation, 17: 15884 (TID-16522)
deuteron elastic scattering at 6.5 Mev, polarization, 17: 17263
effects on corrosion of molybdenum by rubidium, 17: 16634 (AGN-8063)
melting effects on work hardening properties of, electron beam and inert gas arc, 17: 16712
meson (μ) decay in, 17: 17297
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
TITANIUM ALLOYS
production of, that remain ductile after welding, 17: 16580(P)
Al–Cr–Fe–Ni–Ti, precipitation processes in, 17: 16718
Al–Cr–Ti, transformation behavior in, during cooling, 17: 16721
Al–Mo–Ti, transformation behavior in, during cooling, 17: 16721
Al–Ti, mechanical properties and strength, 17: 16677
Al–Ti–V, transformation behavior in, during cooling, 17: 16721
Cr–Nb–Ti, phase studies, 17: 16543
Mo–Ti, thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
Nb–Ti–Zr, fabrication of high-quality tubing of, 17: 16603 (ANL-FGF-409)
Pu–Ti, phase studies, 17: 16566
Ti–V, electronic specific heat, 17: 16698
TITANIUM BORIDES
emissivity, measurement of spectral, 17: 16632(R) (AD-274654)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
TITANIUM CARBIDES
radiation and temperature effects on mechanical and physical properties of, 17: 16760
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
NiC–TiC, emissivity of, measurements of, 17: 16787(R) (PWA-2163)
TITANIUM FILMS
sorptive properties for gases in vacuum systems, 17: 17337(R) (ORNL-3392(p.86-8))
TITANIUM ISOTOPES Ti-46
Coulomb excitation of, reorientation effects in, 17: 17140
TITANIUM NITRIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
TITANIUM OXIDE FILMS
stresses in, measurements of, 17: 16685
TITANIUM OXIDES
emissivity of, measurements of, 17: 16787(R) (PWA-2163)
TITANIUM SYSTEMS
B–Cr–Ti, phase sutides of, 17: 16711
Cr–Si–Ti, oxidation resistance properties as coating for niobium alloys, 17: 16633(R) (AD-296341)
TITRATION EQUIPMENT
development of coulometric, 17: 15851(R) (ORNL-3397(p.1-16))
TOLUENE
association constants of, with chloranil, deuterium isotope effects in, 17: 15991
radioinduced reactions with cyanogen, 17: 16042(R) (SRO-78)
TRACER TECHNIQUES
development of post-activation, for process analyses, 17: 15913
radioautography, principles and procedures, 17: 15698
TRACER TECHNIQUES (AGRICULTURE)
in studies of the use of wetting agents in foliar nutrition, 17: 15557
review, 17: 15556
TRACER TECHNIQUES (BIOLOGY)
detection of pericardial effusion using, 17: 15582
for erythrokinetic studies of anemia, 17: 15577
review, 17: 15556
use in studies on insects, 17: 15559
TRACER TECHNIQUES (CHEMISTRY)
development, 17: 15858(R) (ORNL-3397(p.71-112))
use in determining radioisotope ion exchange, 17: 16138 (AE-103)
TRACER TECHNIQUES (ENGINEERING)
ablation studies, 17: 16223 (GAMD-2117)
TRACER TECHNIQUES (MEDICINE)
for measuring brain blood flow, 17: 15580
TRANSDUCERS
development of, for nuclear rockets, 17: 16384 (LADC-5679)
TRANSFORMATION TEMPERATURES
relation to, of ductile-brittle transition in steel, development of method for determining, 17: 16644(R) (EURAEC-561)
TRANSISTORS
production, process for, 17: 16629(P)
radiation effects on lifetimes and reliabilities of, 17: 16882
TRANSPLUTONIC ELEMENTS
chemistry of, review, 17: 15983
TREES
effects of chronic, low-level exposure on growth and reproduction in pine-oak forest, 17: 15730
iodine-131 uptake by pine, effects of soil sterilization with methyl bromide, 17: 15735
radiation effects on growth and morphology of *Pinus monophylla*, acute gamma exposure, 17: 15733
radiation effects on growth and development in *Quercus alba*, chronic, low-level exposure, 17: 15734
radiation effects on the ecology of loblolly pine, 17: 15802
TRIISOÖCTYLAMINE
solvent properties of, for plutonium nitrates, 17: 16154
TRIMETHYLAMINE
radiolysis products of, 17: 16043(R) (TID-18094)

TRIOCTYLAMINE
solvent properties of, for plutonium nitrates, 17: 16154
solvent properties of, for neptunium, plutonium, and uranium, 17: 16156
TRIPHENYLAMINE
spectra of molecular transfer complexes of, 17: 16785 (NYO-3062)
TRITIUM
content in PWR primary coolant, reduction of, by use of lithium-7 resin, 17: 17572 (WAPD-PWR-TE-103)
counting of, design of gas-phase system for, 17: 15871 (AEET/HP/TM-10)
detection and measurement using liquid scintillation counters, 17: 16457
detection and measurement, effects of sample-holder material on, 17: 16458
deuteron reactions(d,n), neutron polarization from, 17: 17125 (TID-18137)
deuteron reactions (d,n) at 16 and 24 Mev, neutron polarization in, 17: 17083
deuteron reactions (d,np) and (d,2n) at 5 to 12 Mev, neutron spectra and angular distributions, 17: 17086
effects of radiation from incorporated, on development of plant cells, 17: 15653
hyperfine structure in atomic, state-dependent mass corrections to, 17: 16847
proton reactions(p,n), neutron polarization from, 17: 17125 (TID-18137)
separation from deuterium and protium electrolytic refining process for, 17: 16489 (DP-261)
use in radioautographic studies of hydrogen in aluminum, 17: 16539
TRITONS
binding energy of $_1H^3$, 17: 17014
formation at capture of stopped π^--mesons by light nuclei, 17: 17273
ranges and stopping cross sections of low-energy, 17: 17212
TRYPTOPHAN
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668
protective effects of, against radiation in mice, 17: 15826
TUBES
creep-rupture properties of thin-wall type 316 stainless steel, 17: 16682
design of concentric pair, with spacers permitting relative axial movement, 17: 16209(P)
fabrication of high-quality, deformable core drawing procedures for, 17: 16603 (ANL-FGF-409)
flow of steam-water mixtures in annuli, two-phase critical, 17: 16239
TUMORS
metastasis frequency, effects of whole-body x irradiation, 17: 15831
radiation effects on Ehrlich ascites, direct and indirect, 17: 15769
radioinduced, acceleration by injection of carbon tetrachloride in mice, 17: 15643 (USNRDL-TR-596)
radioinduced on skin, histology of, 17: 15806
radiosensitivity, 17: 15664
radiosensitivity, effects of oxygen, 17: 15688
radiosensitivity of Ehrlich ascites, effects of temperature on, 17: 15722
radiosensitivity of predecessors, modification by previous irradiation, 17: 15671
radiotherapy, effects of fractionated dose, 17: 15657
radiotherapy, time-dose relationship, 17: 15658
radiotherapy, time-dose relationship, 17: 15659
radiotherapy, time-dose relationship, 17: 15660
radiotherapy with internal applications, review, 17: 15800
therapy of malignant, using phosphorus-32-labeled colloid, 17: 15714
treatment using supervolt therapy, 17: 15576
TUNGSTEN
alloying effects on titanium, 17: 16580(P)
casting, melting, and properties of, 17: 16532
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
neutron elastic low-angle scattering at 14.2 Mev, 17: 17097
properties for exothermic brazing, 17: 16608(R) (NP-12615)
radiation and temperature effects on mechanical and physical properties of, 17: 16760
sorption of potassium and cesium on, thermal accommodation of rare gases during, 17: 16027
sorptive properties, effects of electron bombardment, 17: 16713(T)
tensile properties of, compilation of, 17: 16639 (DMIC-Memo-157)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
use for shielding for cobalt-60 gamma sources, 17: 15663
TUNGSTEN ALLOYS
Hf–Nb–W, phase equilibria of niobium-rich regions, 17: 16641(R) (DRI-2091)
Nb–Ta–W, mechanical properties at 2600°F of coated, evaluation of, 17: 16633(R) (AD-296341)
Nb–W–Zr, phase equilibria of niobium-rich regions, 17: 16641(R) (DRI-2091)
W–U, analysis for uranium, spectrophotometric, 17: 15876 (LA-2844)
TUNGSTEN BORIDES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
TUNGSTEN CARBIDES
structure of, neutron and x-ray diffraction study of, 17: 16708
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
UWC_2, thermionic emission constants of, 17: 16783 (LADC-5128)
TUNGSTEN ISOTOPES W-180
isomeric transitions, 17: 17147
TUNGSTEN ISOTOPES W-182
deuteron reaction (d,p), study of low-lying levels by, 17: 17232
TUNGSTEN ISOTOPES W-183
deuteron reaction (d,p), study of low-lying levels by, 17: 17232
TUNGSTEN ISOTOPES W-184
deuteron reaction (d,p), study of low-lying levels by, 17: 17232
TUNGSTEN ISOTOPES W-186
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
TUNGSTEN ISOTOPES W-187
gamma spectra, 17: 17165
TUNGSTEN OXIDE FILMS
stresses in, measurements of, 17: 16685
TUNGSTEN OXIDES
$NiO–WO_3$, radiation effects on catalytic activity in hydrodesulfurization of hydrocarbons, 17: 16117(P)
TUNGSTEN SYSTEMS
Nb–Si–W, properties and structure of, 17: 16710
TURBINES
bearings for, development of gas-lubricated, 17: 16182(R) (TID-18292)
feedwater temperature control system for, 17: 16198(P)
testing of, for demonstration power plant, 17: 17541(R) (IDO-28602)
TYROSINE
protective effects of, on hemagglutinin and infectivity of influenza virus, 17: 15668

U

ULTRASONICS
use in determining nuclear magnetic resonance in silicon, 17: 16779 (ISS-62/17)
ULTRAVIOLET RADIATION
biological effects on Euglena, 17: 15640 (TID-18203)
development of light sources for, 17: 16383 (JÜL-88-PP)
effects of, on mussel gills, protective effects of benzimidazoles against, 17: 15674(T)
effects on nucleic acid synthesis in *S. typhimurium*, 17: 15777
lethal effects on yeasts, 17: 15793
lethal effects on *Shigella sonnei*, effects of surface tension of the medium, 17: 15721
UMOHOITES
structure, 17: 15984
UNDERGROUND EXPLOSIONS
detection and inspection of nuclear, on-site, 17: 16906
detection of nuclear, seismographic, 17: 16905
earth motion from, 17: 16265 (PNE-111F)
geologic effects of high-explosive tests at Nevada Test Site, 17: 15540
nuclear seismic measurements of STOAT, 17: 16262 (AD-297344)
seismic wave amplitudes from, in four media, 17: 16286
seismic wave generation by, and collapse of cavities, 17: 16287
UNDERGROUND STRUCTURES
total effects of nuclear explosions on protective, 17: 16330 (P-1951 (RAND))
URACIL, 5-FLUORO-

effects on radiosensitization of tumors, 17: 15669
URANIUM
alkali metal fluoride–U, spectra of, magneto-electric transitions in, 17: 15981
analysis for iron, absorptiometric method for, 17: 15879 (PG-Report-276)
analysis of, for carbon, oxygen, and metals, 17: 15892
content in Black Sea, 17: 16276
determination in dissolver solutions, coulometric, 17: 15852(R) (ORNL-3397(p.17-24))
determination in granite, spectrophotometric, 17: 15861(R) (ORNL-3397 (p.117-21))
determination in plutonium mixtures, comparison of methods for, 17: 16524(R) (NUMEC-P-103)
determination in niobium-uranium alloys, coulometric, 17: 15852(R) (ORNL-3397(p.17-24))
determination in ocean-bottom cores by radiation spectra analysis, 17: 15886 (TID-18125)
determination in uranium–tungsten mixtures, spectrophotometric method for, 17: 15876 (LA-2844)
determination of, in TBP/kerosene solutions, by x-ray fluorescence, 17: 15883 (PG-Report-428)
determination of, luminescent, 17: 15928
determination of microgram amounts, neutron activation method for, 17: 15887 (TID-18204)
determination of, using arsenazo III in strong acid solutions, photometric, 17: 15931
determination, quantitative radioautographic, 17: 15895
determination using graphite electrode, amperometric, 17: 15922
development as reactor fuel, 17: 17444
dislocation loop orientation in alpha, 17: 16686
extraction of, bibliography for, 17: 16147 (VDIT-68)
extrusion of, by DYNAPAK method, 17: 16604 (BRB-69)
fabrication of enriched 93-wt.% uranium-235 and depleted, 17: 17591 (ANL-6107)
luminescence of, effects of impurities on, 17: 15928
neutron elastic low-angle scattering at 14.2 Mev, 17: 17097
neutron elastic scattering by, cross sections for, 17: 17159
oxidation state, effect on stability of lead isotopes from, 17: 16301
processing of, safety in, 17: 16351
production by electrorefining, 17: 17454
production, electrolytic, 17: 16134(P)
production of reactor grade, technology of, 17: 16124
production, review, 17: 17449
proton reaction at 120 and 660 Mev, 17: 17149
radiation and temperature effects on mechanical and physical properties of, 17: 16760
recovery of, from lignites by acid leaching, 17: 16153
separation from carbonate leach solutions, 17: 16133(P)
separation from fission products by gradient multistage extraction using TBP, 17: 16158
separation from irradiated fuels by two-stage differential solvent extraction using TBP and sulfate ion, 17: 16145 (ORNL-3312)
separation from ores by carbonate leaching, control of carbonate concentration in, 17: 16135(P)
separation from ores by carbonate leaching, catalytic oxidation in, 17: 16137(P)
separation from ore concentrate by solvent extraction using TBP, effects of nickel arsenides on, 17: 16144 (NLCO-867)
separation from ore by carbonate leaching, prevention of uranium loss in barren liquor, 17: 16136(P)
separation of, from uraniferous minerals, extraction technique for, 17: 16123
separation of, from nitric acid by solvent extraction using tridodecylamine, 17: 16155
separation of, from hydrochloric acid by solvent extraction using trioctylamine, 17: 16156
separation of hexavalent, from aqueous solutions by anion exchange, bibliography on, 17: 16148 (VDIT-70)
solubility in bismuth, 17: 16574
structure, 17: 16559
swelling of, surface-diffusion bubble growth theory of, 17: 16643(R) (EURAEC-548)
thermal expansion, x-ray studies, 17: 16668
uses for depleted, review of, 17: 16515 (DMIC-Memo-165)
URANIUM (Zr ALLOY CLAD)
dissolution, 17: 16167(P)
URANIUM ALLOYS
development as reactor fuel, 17: 17444
dissolution, 17: 16167(P)
Al–U, preparation of, uranium-235 loading control in, 17: 17598 (TID-18121)
Cr–U, phase transformation curves of, tempered from β region, 17: 16671
Mo–Pu–U, radiation effects on, 17: 16572
Mo–U, analysis for molybdenum, gravimetric, 17: 15882 (PG-Report-418)
Mo–U, formation of oriented oxide films on gamma-phase, 17: 16536
Mo–U, use as reactor fuels, burnup and cost studies for, 17: 16521 (NAA-SR-Memo-2974)
Nb–U, formation of oriented oxide films on gamma-phase, 17: 16536
Nb–U, phase transformation, effects of cooling rate on onset temperature for $\gamma \rightarrow \beta$, 17: 16672
Pu–U, phase diagram, 17: 16566
Pu–U, preparation, 17: 16568
Pu–U, properties as reactor fuel, 17: 16571
Pu–U, radiation effects on, 17: 16572
U–Pu, phase diagram, 17: 16567
U–Zr, analysis of, for zirconium, 17: 15892
W–U, analysis for uranium, spectrophotometric, 17: 15876 (LA-2844)
URANIUM CARBIDE COMPACTS
production, 17: 16624(P)
URANIUM CARBIDES
analysis for oxygen, vacuum fusion methods for, 17: 15872 (AERE-R-4216)
decomposition of, thermal, 17: 15955 (PWAC-378)
diffusion and evolution of xenon-133 from bulk, at 800 to 1600°C, 17: 16665(T,R) (EURAEC-363)
fabrication process for, 17: 16619(P)
fission gas release from irradiated, 17: 15532(R) (BMI-1607(Del.))
fission product release from, in in-pile burning or melting, 17: 16324(R) (ORNL-3401(p.27-35))
hydrolysis products, determination by chromatography, 17: 15855(R) (ORNL-3397(p.38-54))
preparation from fluorides, 17: 17454
production from uranium and graphite powder mixture, method for, 17: 16528(T,R) (EURAEC-126)
production of, method and electrode for, 17: 16029(P)
production, review, 17: 17449
properties as high-temperature sodium-cooled reactor fuels, 17: 16650 (NAA-SR-7696)
radiation effects on stability of, 17: 15532(R) (BMI-1607(Del.))
reactions of mono-, with beryllium at 700 to 1000°C, 17: 16537
thermionic emission constants of, 17: 16783 (LADC-5128)
UC–ZrC, cathode vapor loss of, physical and chemical redeposition methods for reduction of, 17: 16774(R) (GA-3642)
UC–ZrC, electron emission and vaporization, 17: 16516(R) (GA-3866)
$UMoC_2$, thermionic emission constants of, 17: 16783 (LADC-5128)
UWC_2, thermionic emission constants of, 17: 16783 (LADC-5128)
URANIUM CHELATES
composition and stability of uranium(VI)–chromotropic acid chelate, 17: 16073
URANIUM COMPLEXES
with humic acid, 17: 15968
URANIUM COMPOUNDS
analysis for impurities, preparative treatment for spectrographic, 17: 15880 (PG-Report-393)
analysis for iron, absorptiometric method for, 17: 15879 (PG-Report-276)
development as reactor fuel, 17: 17444
preparation and properties of pentaalkoxides, 17: 15994
URANIUM CRYSTALS
deformation of alpha poly-, effects of thermal cycling, 17: 16689
URANIUM DEPOSITS (INDIA)
geochemistry of natural waters in Umra, Rajasthan, 17: 16303
URANIUM(III) FLUORIDES
spectra of, absorption, 17: 15854(R) (ORNL-3397(p.26-38))
URANIUM(IV) FLUORIDES

preparation from uranium dioxide, 17: 17454
URANIUM(VI) FLUORIDES
shipping of, design of bomb for, 17: 16126
URANIUM ISOTOPES
maximum permissible limits in air, 17: 16555
URANIUM ISOTOPES U-233
neutron resonance integrals for, fast, 17: 17470
URANIUM ISOTOPES U-235
fission of, gamma angular distribution from, 17: 17203
fission of, production of x radiation in, 17: 17250
helium-ion fission mass yield curves of, study of symmetric region of, 17: 17126 (TID-18165)
neutron fission cross sections and resonance parameters at 0.03 to 60 ev, 17: 17129 (UCRL-6926)
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
neutron resonance integrals for, fast, 17: 17470
URANIUM ISOTOPES U-238
helium-ion fission mass yield curves of, study of symmetric region of, 17: 17126 (TID-18165)
neon-22 fission of, charge distribution curve and product yields for, 17: 17114 (JINR-P-1148)
neutron fission lifetime, 17: 17299
neutron resonance integrals and self-shielding factors for detector foils of, 17: 17106 (DP-817)
neutron resonance integrals for, fast, 17: 17470
neutron resonance capture in, 17: 17419(R) (MITNE-26)
proton fission at 150-Mev, kinetic energies and ranges of fragments from, 17: 16051(R) (TID-18261(p.27-43))
proton fission at 20 Bev, 17: 17180
URANIUM ISOTOPES U-239
neutron fission lifetime of compound nuclei of, 17: 17299
use in determination of trace quantities of uranium by neutron activation analysis, 17: 15887 (TID-18204)
URANIUM LEACH SOLUTIONS
separation of scandium from, spectrographic, 17: 16164
URANIUM LEACH SOLUTIONS (CARBONATE)
control of carbonate concentration in, 17: 16135(P)
separation of uranium from, 17: 16133(P)
URANIUM MINERALS
age estimation, methods for evaluating discordant lead-isotope ages, 17: 16308
URANIUM NITRIDE COMPACTS
production, 17: 16622(P)
URANIUM ORES
analysis for thorium, by ion exchange-spectrographic methods, 17: 15898
carbonate leaching, control of carbonate concentration during, 17: 16135(P)
processing, design of systems for, 17: 17454
separation of uranium from, by carbonate leaching, 17: 16136(P)
separation of uranium from, by carbonate leaching with catalytic oxidation, 17: 16137(P)
URANIUM(IV) OXIDE COMPACTS
production of high-density sintered, 17: 16621(P)
URANIUM OXIDE CRYSTALS
physical properties of single, 17: 16642(R) (EURAEC-524)
URANIUM OXIDE FILMS
formation of oriented, on gamma-phase uranium alloys, 17: 16536
URANIUM OXIDE POWDERS
sintering properties of, particle surface effects on, 17: 16606 (JEN-81-DMe/16)
URANIUM(IV) OXIDE POWDERS
density of enriched fuel materials, 17: 15532(R) (BMI-1607(Del.))
preparation, 17: 16127(P)
production, 17: 16132(P)
surface area measurement by isotope exchange, 17: 15858(R) (ORNL-3397(p.71-112))
swaging of, effects of method of preparation on, 17: 16610(T,R) (EURAEC-522)
URANIUM OXIDE SLURRIES
preparation of uranium dioxide for use in, 17: 16127(P)
URANIUM OXIDES
analysis of, for carbon, oxygen, and metals, 17: 15892
preparation in fibrized glass, for fuel element use, 17: 16525(R) (NYO-9736)
properties as reactor fuel, 17: 16576
reduction to dioxide, rotary kiln for, 17: 16128(P)
reduction to dioxide, continuous, 17: 16129(P)
UO_2–ZrO_2, fabrication, 17: 15532(R) (BMI-1607(Del.))
URANIUM OXIDES (Zr ALLOY CLAD)
radiation effects on dimensional stability of, 17: 16735 (EXP-NRX-2807)
URANIUM(IV) OXIDES
analysis of irradiated after 5806 full power hours in PWR, 17: 17574 (WAPD-T-1461)
cladding of, development of alumina and beryllia for, 17: 15532(R) (BMI-1607(Del.))
creep deformation of stoichiometric sintered, at 1250 to 1400°C, 17: 16687
fabrication of boron carbide burnable poison containing, 17: 16605(R) (CEND-173)
fission gas release from, 17: 16645(R) (EURAEC-568)
fission product diffusion and release from, in out-of-pile melting, 17: 16323(R) (ORNL-3401(p.5-27))
fission product release from, in in-pile burning or melting, 17: 16324(R) (ORNL-3401(p.27-35))
fission product release from, on in-pile melting, 17: 16325(R) (ORNL-3401(p.35-9))
fluoride films on, spectrophotometric method of determination of refractive indices of, 17: 15949 (LADC-5374)
neutron scattering in, effects on fission rate and reactivity of, 17: 16738(R) (GEAP-4081)
precipitation of uranium metal in oxygen-deficient, 17: 16693
preparation of granular spheres for use in reactor aqueous slurry, 17: 16623(P)
production by conversion from hexafluoride, 17: 17454
production by reduction of higher oxides, continuous, 17: 16129(P)
production from uranium trioxide, apparatus and method for continuous, 17: 16131(P)
production, review, 17: 17449
radiation effects at exposures of 100 to 3200 Mwd/t, 17: 16739 (GEAP-4107)
reactions with carbon in arcs, uranium carbide production by, 17: 16029(P)
stability of alumina-coated particulate at 1100°C, 17: 15532(R) (BMI-1607(Del.))
thermal expansion, x-ray studies, 17: 16668
glass–UO_2, fabrication, 17: 17478(P)
PuO_2–UO_2, fabrication and radiation behavior of fuel cycle specimens, 17: 17409(R) (GEAP-3811)
PuO_2–UO_2, properties of coprecipated, 17: 16524(R) (NUMEC-P-103)
PuO_2–UO_2, sintering studies on oxalate precipitated, 17: 16524(R) (NUMEC-P-103)
UO_2–UP_2O_7, thermal expansion, 17: 16680
URANIUM(IV-VI) OXIDES
magnetic susceptibility, 17: 16674
reduction using ammonia, 17: 16125
URANIUM(VI) OXIDES
reactions with carbon dioxide in aqueous solution, 17: 15969
reduction to dioxide, apparatus and method for continuous, 17: 16131(P)
URANIUM PEROXIDES
precipitation of, with neptunium, plutonium, and thorium, 17: 16079
URANIUM POWDERS
reactions with carbon dioxide, mechanism, 17: 15980
URANIUM PYROPHOSPHATES
thermal expansion, 17: 16680
UO_2–UP_2O_7, thermal expansion, 17: 16680
URANIUM SYSTEMS
C–O–U, phase studies, 17: 16522(R) (NCSC-2663-10)
Mo–UO_2, properties at high temperatures, 17: 15532(R) (BMI-1607(Del.))
Si–U, analysis of, for silicon, 17: 15892
URANYL CARBONATES
complexes, preparation by reaction of carbon dioxide with uranium trioxide, 17: 15969
URANYL CHLORIDES

electrolysis in molten salt eutectic, mechanism, 17: 16005
URANYL NITRATES
analysis for nitrates and nitric acid, volumetric, 17: 15875 (HW-76363)
reactions with ammonium and sodium hydroxides, conductometric studies, 17: 15999
reduction to uranium dioxide powder, 17: 16127(P)
reduction to uranium(IV) oxide powder, 17: 16132(P)
separation from nitric acid by countercurrent extraction using methylcyclohexanones, 17: 16151
UREA, THIO-
protective effects against x radiation in animal cells, 17: 15769
URIDINE
effects on radiosensitization of tumors, 17: 15669
5-iododeoxy-, radiosensitivity effects on human cell cultures, 17: 15670
URINE
cesium-137 content in human, estimation of body burden from, 17: 16343
excretion of tritium-labeled normorphine in, of dogs and monkeys, 17: 15601
radiation effects on amino acid levels in, 17: 15784

V

VACUUM FURNACES
design for melting and casting uranium, 17: 16579(P)
VACUUM FUSION ANALYSIS
equipment design and operation for determination of oxygen in uranium and plutonium carbides by, 17: 15872 (AERE-R-4216)
VACUUM GAGES
calibration of nude, for pump fluids, 17: 17337(R) (ORNL-3392(p.86-8))
capabilities and operational principles of, survey of, 17: 16172 (BNL-6796)
properties of inverted and glass-tube Bayard-Alpert, 17: 16184(T) (AERE-Trans-920)
VACUUM PUMPS
capabilities and operational principles of, survey of, 17: 16172 (BNL-6796)
design of rotor-stator, 17: 16215(P)
testing turbo-molecular, sorption effects on maximum vacuum and pumped volume, 17: 16184(T) (AERE-Trans-920)
VACUUM SYSTEMS
development at ORNL, 17: 17337(R) (ORNL-3392(p.86-8))
development of, linear accelerator, 17: 17317(R) (SLAC-8)
production of pressure difference between interconnected chambers of, apparatus design for, 17: 16215(P)
VACUUM TECHNIQUES
development of ultrahigh, 17: 16181(R) (TID-18283)
survey, 17: 16172 (BNL-6796)
VACUUM VALVES
development of, for electron guns, 17: 17317(R) (SLAC-8)
tests of waveguide, 17: 17317(R) (SLAC-8)
VACUUM VESSELS
interlock system for, 17: 16199(P)
VALINE
radiosensitivity effects on paramecia, 17: 15737
VALLECITOS SUPERHEAT REACTOR
development, 17: 17538(R) (GEAP-4105)
VALVES
design of fluid-tight, 17: 16208(P)
VAN ALLEN RADIATION BELTS
effects on silicon solar cells, 17: 16884
effects on space vehicles, 17: 16876
electron increases in, from high-altitude nuclear explosions, 17: 16875
electron intensity in inner zone of, 17: 16920
energy spectrum of trapped particles in, August and September 1959, 17: 16937
proton flux in inner, east-west asymmetry in, 17: 16918 (UCRL-10587)
shielding of manned space vehicles from, 17: 16877
VANADIUM
alloying effects on titanium, 17: 16580(P)
determination in graphite, activation, 17: 15916
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
VANADIUM ALLOYS
Al–Ti–V, transformation behavior in, during cooling, 17: 16721
Cr–V, electronic specific heat, 17: 16698
Cr–V, nuclear magnetic resonance, 17: 16820
Hf–V, phase studies, 17: 17446
Ni–V, electronic specific heat, 17: 16698
Pu–V, phase diagram, 17: 16567
Ru–V, crystal structure of intermetallic compounds and saturated solid solutions in, 17: 16717
Ti–V, electronic specific heat, 17: 16698
VANADIUM CARBIDES
radiation and temperature effects on mechanical and physical properties of, 17: 16760
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
VANADIUM ISOTOPES V-51
nuclear magnetic resonance in chromium–vanadium alloys, 17: 16820
proton reactions (p,n) on, spectra from, 17: 17226
VANADIUM OXIDES
oxygen-18 exchange reactions with, kinetics and mechanisms of, 17: 15979
radiation and temperature effects on mechanical and physical properties of, 17: 16760
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970
VANADIUM SYSTEMS
C–Hf–Nb–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–Nb–Ta–V–Zr, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–Nb–Zr–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
VAPOR PRESSURE
measurement at low temperatures, procedures for, 17: 15952 (LADC-5711)
VAPORIZATION
measurement at high temperatures, 17: 16632(R) (AD-274654)
VELA PROJECT
seismic measurements of STOAT explosion in, 17: 16262 (AD-297344)
status of Vela Uniform, 17: 16906
VESSELS
design of shipping, for uranium hexafluoride, 17: 16126
VITAMIN A
metabolic effects, 17: 16360(R) (NP-12597)
VITAMIN B_6
radiation effects on, oxygen effect in, 17: 15774
VITAMIN B_{12}
metabolism in irradiated rats, 17: 15836
VITAMIN K
effect on protein synthesis in rats, 17: 16359(R) (NP-12596)
effects on hemorrhage in rats, 17: 16364(R) (NP-12602)
metabolic effects, 17: 16360(R) (NP-12597)
VOLATILITY SEPARATION PROCESSES
construction materials for fused-salt, corrosion behavior of, 17: 17451
VOLTAMMETRY
development for use in molten salt studies, 17: 15853(R) (ORNL-3397 (p.24-6))
sensitivity of d-c, effects of various mercury cathodes on, 17: 15851(R) (ORNL-3397(p.1-16))
VOLUMETRIC ANALYSIS
development of micro methods of, 17: 15854(R) (ORNL-3397(p.26-38))

W

WASTE DISPOSAL
in deep wells, by hydraulic fracturing, 17: 17619(R) (ORNL-TM-482)
in natural salt formation, 17: 17619(R) (ORNL-TM-482)
in salt mines, for calcined materials, 17: 17453
marine, design of containers for, 17: 17453
review, 17: 17449
underground tanks, model study of flow in, 17: 17615(R) (HW-76262)
WASTE PROCESSING
calcination, design of pilot plant for demonstration of, 17: 17616 (IDO-14596)
calcination, effects of magnesium and sugar on ruthenium volatility in,

17: 17615(R) (HW-76262)
calcination of, equipment feasibility studies for, 17: 17619(R) (ORNL-TM-482)
conversion to solids, for highly active materials, 17: 17453
fixation in glass, 17: 17619(R) (ORNL-TM-482)
fixation of ruthenium in solids, 17: 17618 (ORNL-TM-263)
foam separation and ion exchange, review of, 17: 17453
methods development and evaluation, 17: 17619(R) (ORNL-TM-482)
methods for, research progress in Belgium, 17: 17620(T,R) (EURAEC-518)
methods of, for solid wastes, 17: 17614 (CEA-2195)
plant design and operation for radioactive, at Rey, Czechoslovakia, 17: 17621
temperature rises resulting from storage of high-level wastes, analytical evaluation of, 17: 17617 (LADC-5366)

WATER
air-water, flow through tubes, 17: 16233(R) (TID-18141)
boiling phenomena in high-pressure, photographic studies of, 17: 16235 (WAPD-T-1566)
content of, in building materials, thermal neutron diffusion method for determination of, 17: 15902
convection transients from flat vertical surfaces, natural, 17: 16246
corrosive effects on iron, 17: 16600
decontamination, electrodialytic, 17: 15867(P)
deuterium exchange with hypophosphorous acid, kinetics, 17: 15988
deuterium exchange with p-xylene, geometric factor in catalytic, 17: 15863
effects on neutron multiplication in heavy-water-moderated reactor, 17: 17432
effects on radioinduced graft polymerization, 17: 16041(R) (NCSC-2477-10)
gamma attenuation by, effects of spherical voids in, 17: 17404(R) (BNL-164)
radioactivity of, in Czechoslovakia, measurement methods of, 17: 15616(T) (JPRS-18391)
radiolysis of, effects of pH on hydrogen peroxide formation in, 17: 16058(R) (AEC-tr-5687)
radiolysis of, lectures on effects in EBWR, 17: 17403 (ANL-6640)
radiosensitivity effects in barley and maize seeds, 17: 15799
reactions with steel at high temperatures, survey of mechanism, 17: 16601
reactions with zirconium at high temperatures, 17: 17447
separation from air and steam by gravity, carry-under studies, 17: 16240
steam-water, two-phase critical flow in annuli, 17: 16239
HF-water, proton magnetic resonance, relations of concentration with proton chemical shifts, 17: 15963 (TID-18200)

WATER-d_2
effects on acid ionization constants, 17: 16022
enrichment, electrochemical process for, 17: 16493
preparation of, sieve tests in plants for, 17: 17546(R) (SRO-80)
research on uranium lattices moderated by, experimental and theoretical, 17: 17419(R) (MITNE-26)

WATER COOLED REACTORS
control by variation of water-d_2 concentration, 17: 17527(P)
development of, design and testing of equipment for studies in, 17: 17407(R) (EURAEC-537)

WATER MODERATED REACTORS
development, 17: 17404(R) (BNL-164)
model for plutonium burnup in, 17: 16738(R) (GEAP-4081)

WATER VAPOR
sticking factors for, on titanium film, 17: 17337(R) (ORNL-3392 3392(p.86-8))

WEAR
measurement of, use of radioisotopes for, 17: 16377

WELDED JOINTS
properties and structure of seam welds in reactor pressure vessel, 17: 17440

WELDING
equipment for electron-beam, 17: 16631(P)
techniques for, of reactor steels, 17: 16616

WELL LOGGING
equipment design for simultaneous density and natural gamma-ray logging, 17: 16408(P)
method for locating cement in boreholes, 17: 16414(P)
neutron apparatus with spectral selectivity, 17: 16412(P)
neutron-epithermal neutron apparatus for measuring porosity, 17: 16410(P)
neutron-gamma apparatus, 17: 16395(P)
neutron-gamma apparatus for identifying elements by delayed coincidence, 17: 16413(P)
neutron source design for, 17: 16415(P)

WHEAT
chemically-induced mutations, 17: 15731
radiation effects on cell growth in leaves, 17: 15651
radiation effects on, seed and seedling neutron exposure, 17: 15748
radioinduced mutations, 17: 15731

WHITE OAK CREEK
radioactivity of, Aug. to Oct. 1962, 17: 17619(R) (ORNL-TM-482)

WOOD
radiation effects, 17: 16108

X

X RADIATION
atmospheric ionization by, from high-altitude explosions, 17: 16292
biochemical effects on blood-serum and hepatic proteins, 17: 15770
biological effects on skin, 17: 15757
biological effects on DNA, 17: 15792
biological effects on spleen lymphoid centers in mice, effects of thymus on, 17: 15752
biological effects on amino acid levels in plasma and urine of cancer patients, 17: 15784
biological effects of divided doses in large and small mammals, 17: 15804 (USNRDL-TR-606)
burden and exposure time of, at 60 to 200 kv, effect of various screen combinations on, 17: 15676
carcinogenic effects of soft, on mice, 17: 15823
chemical effects on nucleic acids and nucleoproteins, 17: 15771
chemical effects on glucose oxidase and riboflavin, 17: 15774
chemical effects on 3-indoleacetic acid, 17: 15776
chemical effects on DNA, 17: 15792
detection and measurement by free-air ionization chambers, 17: 16423 (ISS-62/9)
detection and measurement by use of air ionization chambers, 17: 16424 (ISS-62/10)
diffraction of, line breadths and peak height for α_1 α_2 doubling effects in, 17: 15873 (AERE-R-4218)
dose measurements, 17: 16350
effects in Drosophila, genetic, 17: 15681
effects of fetal irradiation on behavior of 100-day-old male rats, 17: 15655
effects of methionine sulfoximine on distribution of potassium in rat tissues, tracer study, 17: 15687
effects of, on adrenocortical steroid synthesis in rats, whole-body, 17: 15808
effects of, on buccal cells in rabbits, sensitizing effects of testosterone on, 17: 15666
effects of, on course of *Trypanosoma lewisi* infection in rats, 17: 15573
effects of, on cytoplasm of distal tubule cells of kidneys in mice, 17: 15713
effects of, on erythropoiesis in rats, reactivation effects of cobalt on, 17: 15810
effects of, on glomerulus and proximal tubule of kidneys, in mice, 17: 15712
effects of, on incidence and latent period of leukemia in mice, 17: 15724
effects of, on leukocytes in peripheral blood in rats, effects of ribonucleic acid on, 17: 15692
effects of, on Leydig cells in rats, 17: 15693
effects of, on liver in mice, protective effects of 2-methylpiperazine dithioformate against, 17: 15809
effects of, on mice, protective effects of spleen cell injection or splenectomy on, 17: 15811
effects of, on mice, effects of lipoxidase and olive oil on, 17: 15813
effects of, on mitosis in crystalline lens in rabbits, 17: 15818(T)
effects of, on mutations in *Neurospora crassa*, 17: 15652

effects of, on oocyte maturation in ovaries in mice, 17: 15816(T)
effects of, on *Trichinella spiralis*, immunity in mice, 17: 15654
effects of, on 5-hydroxytryptamine in small intestine in guinea pigs, mice, rabbits, and rats, 17: 15705
effects on animal cells, direct and indirect, 17: 15769
effects on bacteriophage properties, 17: 15790
effects on central nervous system of rat embryo, 17: 15745
effects on enzymatic activity of regenerating rat liver, 17: 15785
effects on erythrocytes, effects of monoiodoacetic acid on, 17: 15786
effects on free radical production in biological substances, 17: 15767
effects on immunologic tolerance in rats, 17: 15761
effects on liver metabolism in rats, whole-body exposure, 17: 15570
effects on metastasis frequency of whole-body, 17: 15831
effects on muscle morphology and metabolism, 17: 15641 (TID-18221)
effects on nucleic acid metabolism in rats, whole-body exposure, 17: 15684
effects on nucleic acid metabolism in rats, whole-body exposure, 17: 15685
effects on protein metabolism by liver cells, 17: 15750
effects on protein metabolism in central nervous system and liver, 17: 15781
effects on red cell membranes, 17: 15787
effects on response to skin grafts in mice, 17: 15760
effects on ribonucleic acid metabolism in rat liver, 17: 15798
effects on skin of pigs, effects of dose fractionation, 17: 15662
effects on sodium content of saliva, whole-body exposure, 17: 15719
effects on spleen desoxyribonucleic acid, whole-body exposure, 17: 15636(R) (TID-18061)
effects on synthesis of ascorbic acid in rat liver, whole-body exposure, 17: 15656
effects on translocation of nucleic acids and proteins in germinating barley, 17: 15775
genetic effects in mice, 17: 15629 (LADC-5278)
genetic effects in mice, 17: 15637(R) (TID-18135)
genetic effects in spinach seed, 17: 15682
hazards, nature, and production of, review on, 17: 16335
pathological effects of chronic, low-level exposure in rats, 17: 15805(T) (JPRS-18153)
production of, in fission of uranium-235, 17: 17250
reactions with gases, ion pair production in, 17: 16086
sorption of, by soft tissue near bone, 17: 15702
transmission through germanium single crystals, anomalous, 17: 16861(T)

X-RAY-DIFFRACTION ANALYSIS
line breadths and peak height for α_1 α_2 doubling effects, correction tables for, 17: 15873 (AERE-R-4218)
use of high-temperature, in metallurgy, 17: 16667

X-RAY EQUIPMENT
dental, safety measures in, 17: 16349
design and performance in detecting beryllium impurities, 17: 15890 (Y-1403)
development of, for analysis of various metals and welds, 17: 15857(R) (ORNL-3397(p.57-70))
hazards of, review on external, 17: 16335
survey of dental, in Idaho, 17: 16340

X-RAY SOURCES
development of pulsed, 17: 16044 (TID-18144)

X-RAY SPECTROMETERS
design for parallel solar x rays, 17: 16486(P)
design of sequential, for automatic measurements, 17: 16485(P)

X-RAY SPECTROSCOPY
analysis of minerals, multielement calibration in, 17: 15893
use with electron-beam excitation for determination of light elements, 17: 15908

XENON
atomic transitions of, negative tensor susceptibility for, 17: 17374
binding to halogens, alkali metals, and to itself, 17: 16007
determination in reactor test capsules, chromatographic, 17: 15855(R) (ORNL-3397(p.38-54))
purification method for, 17: 15855(R) (ORNL-3397(p.38-54))
thermal accommodation during adsorption of potassium and cesium on tungsten, 17: 16027
triton ranges and stopping cross sections in, 17: 17212

XENON FLUORIDES
reactions with water, 17: 16020
structure of tetra-, neutron diffraction study, 17: 16023

XENON IONS
reactions on metals, secondary electrons from, 17: 16836

XENON ISOTOPES Xe-133
diffusion from graphite, 17: 16690
diffusion in graphite, mechanisms for, 17: 16744(R) (TID-18112)
diffusion of, from iron–chromium alloys, postirradiation heating effects on, 17: 16638 (BMI-1611)
diffusion of, from uranium carbide and graphite at 800 to 1600°C, 17: 16665(T,R) (EURAEC-363)

XENON SYSTEMS
He–Xe, xenon atomic transitions in, 17: 17374

XYLENE
association constants of, with chloranil, deuterium isotope effects in, 17: 15991
deuterium exchange with water, geometric factor in catalytic, 17: 15863

XYLENOL ORANGE
analytical use of, for spectrophotometric determination of thorium, 17: 15910

Y

YEASTS
phosphorus-32 transmutation in, biological effects of, 17: 15793
radiation effects on diploid, recovery from, 17: 15740
radiation effects on diploid and haploid, effects of post-irradiation nutrient and temperature on, 17: 15739
radiation effects on, lethal curves for beta and ultraviolet, 17: 15793

YTTERBIUM
content of, in marine organisms, 17: 15604
phase transition at 41 kilobars, 17: 16662 (UCRL-10332)
separation of, from rare earth concentrates by solvent extraction using amalgams, 17: 16157
thermal capacity at 0.4 to 4°K, 17: 16015

YTTERBIUM BORIDES
electric conductivity of hexa-, 17: 16726

YTTERBIUM CARBONATES
preparation, properties, and structure, 17: 15950 (LADC-5566)

YTTERBIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001

YTTERBIUM FLUORIDES
preparation, properties, and structure, 17: 15950 (LADC-5566)

YTTERBIUM ISOTOPES Yb-172
energy level de-excitation characters for, experimental 1^-, 17: 17201
energy levels of, half lives of 78.7- and 1174-kev, 17: 17178

YTTERBIUM SULFATES
preparation, properties, and structure, 17: 15950 (LADC-5566)

YTTRIUM
binding with bone and organic compounds, tracer study, 17: 15567
content of, in marine organisms, 17: 15604
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
proton reactions at 100 Mev, isomeric state from, 17: 17141
separation from rare earths by chromate precipitation, 17: 16168(P)

YTTRIUM ALLOYS
Au–Y, crystal structure, 17: 16658 (TID-18197)

YTTRIUM COMPLEXES
with diethylenetriaminepentaacetic acid, formation and stability constants of, 17: 16001

YTTRIUM HYDRIDES
development as reactor moderator material, 17: 17445

YTTRIUM ISOTOPES Y-89
photon reactions (γ,n) on, threshold of, 17: 17158

YTTRIUM ISOTOPES Y-90
analysis of, for contaminant in radioapplicator of, 17: 15911

YTTRIUM ISOTOPES Y-91
uptake by *Gammarus lacustris*, 17: 15623

YTTRIUM OXIDES
effects of, on magnetic properties of magnesium manganese ferrites,

17: 16019
spectra of, in 300 to 1000 mμ region, reflectance, 17: 15970

Z

ZEEP
hot-channel capture and fission measurements in, 17: 17402 (AECL-1684)
ZINC
determination of, in uranium fission products, 17: 15892
distribution of, between nitric acid and ion-exchange resin, synergistic effects of thorium on, 17: 15948 (LA-2836)
magnetoplasma resonance in, 17: 16841
photon elastic scattering at particle threshold energy, cross sections for, 17: 17153
separation of, from indium and gallium using cinnamic acid, 17: 15924
spectra of, low energy neutron-capture gamma, 17: 15943(R) (ARF-1193-20)
spectra of, spin-orbit coupling in band structure, 17: 16845
ZINC COMPLEXES
with dialkyl phosphorodithioic acids, formation, 17: 15858(R) (ORNL-3397(p.71-112))
with *N*-(2-pyridylmethyl)iminodiacetic acid, stability of, 17: 15993
ZINC CRYSTALS
radiation effects on deformation of mercury-coated, 17: 16676
radiation effects on mechanical properties of, in presence of mercury films, 17: 16749
ZINC ISOTOPES Zn-64
deuteron reactions (d,αn), excitation functions and thick-target yields for, 17: 17235
deuteron reactions (d,2p), excitation functions and thick yields for, 17: 17235
proton inelastic scattering, gamma angular distribution from, 17: 17205
proton scattering at 9.6 and 11.7 Mev, excitation levels determined by, 17: 17239
transition mixing ratios (E2/M1) for, measurement of $2^{+\prime} \rightarrow 2^{+}$, 17: 17205
ZINC ISOTOPES Zn-65
distribution of, in *Phaseolus vulgaris* L. during seed germination and young plant development, 17: 15551
gamma spectra, 17: 16438
production of, by 16-Mev cyclotron in Yugoslavia, 17: 17321
sorption of, by lithium halide cation exchange resins, 17: 15992
yields from deuteron reactions in zinc, 17: 17235
ZINC ISOTOPES Zn-66
deuteron reactions (d,α), excitation functions and thick-target yields for, 17: 17235
proton inelastic scattering, gamma angular distribution from, 17: 17205
transition mixing ratios (E2/M1) for, measurement of $2^{+\prime} \rightarrow 2^{+}$, 17: 17205
ZINC ISOTOPES Zn-67
deuteron reactions (d,αn), excitation functions and thick-target yields for, 17: 17235
ZINC ISOTOPES Zn-68
deuteron reactions (d,He^3), excitation functions for, 17: 17234
excited state with energy 232 kev, 17: 17142
ZINC ISOTOPES Zn-72
production in 80-Mev proton fission of terbium-159, absolute cross section for, 17: 16052(R) (TID-18261(p.44-8))
ZINC LANTHANUM NITRATES
cobalt-59 nuclear relaxation in, 17: 16014
ZINC OXIDES
buffer effects of, in spectrochemical analysis of niobium–tantalum mixtures, 17: 15899
ZINC SELENIDES
radiation effects on, electron, 17: 16757
ZIRCALOY-2
corrosion of, and hydrogen sorption by, in reactors, 17: 16598
corrosion of, by steam-water spray, 17: 17406(R) (EURAEC-519)
corrosion of, fretting, 17: 16588 (HW-75626)
creep at 450 to 650°F, 17: 15532(R) (BMI-1607(Del.))
extrusion of tubes, 17: 17546(R) (SRO-80)
hydridation of, effects of stress on, 17: 15958 (TID-16476)
polishing of, development of methods for mechanical, 17: 16656 (TID-16475)
radiation and temperature effects on mechanical and physical properties of, 17: 16760
radiation effects, 17: 17447
ZIRCALOY-3
radiation effects, 17: 17447
ZIRCALOY-4
radiation effects on, 17: 16734 (CVNA-159)
ZIRCONIUM
alloying effects on titanium, 17: 16580(P)
argon-ion reactions on, secondary from, 17: 16836
Auger spectrum, 17: 16810
chemistry of, in industry, 17: 15989
determination by amperometric titration using cupferron, 17: 15861(R) (ORNL-3397(p.117-21))
determination in aluminum, copper, and magnesium alloys, complexometric, 17: 15921
determination of, in uranium–zirconium alloys, 17: 15892
determination of, in presence of alkali metals, chemical spectrographic, 17: 15923
grinding of, operational techniques and recommendations for, 17: 16613
melting effects on work hardening properties of, electron beam and inert gas arc, 17: 16712
oxidation of, effects of modifications of surface films on, 17: 16591(R) (NMI-1254(p.44-65))
plastic deformation of, role of deformation twinning in, 17: 17546(R) (SRO-80)
preparation of, by reduction using magnesium or sodium, 17: 16615
production and properties of, 17: 16707
properties and uses of, mechanical and physical, 17: 16715
radiation effects on oxidation of, 17: 16584(R) (EURAEC-550)
reactions with water at high temperatures, 17: 17447
separation of, from zirconium oxide ores, 17: 16533
solubility in rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
solubility of, in copper, 17: 16706
solvent extraction using TBP, mathematical analysis of, 17: 16165
ZIRCONIUM ALLOYS
corrosion of, by high-temperature steam, cracking of oxide films formed in, 17: 16590(R) (NMI-1254(p.3-43))
corrosion of, in high-temperature steam, mechanisms of, 17: 16589(R) (NMI-1254)
dissolution, 17: 16167(P)
Al–Mo–Sn–Zr, properties as claddings for uranium carbide fuels, 17: 16650 (NAA-SR-7696)
Be–Zr, development of, for high-temperature uses, 17: 16637(R) (BBC-115)
Be–Zr, oxidation of $ZrBe_{13}$ and Zr_2Be_{17} at 1200 to 1800°F, 17: 15947(R) (DRI-2088)
Cr–Fe–Zr, phase studies, 17: 16545
Fe–Zr, phase studies, 17: 16544
Ge–Sn–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Mg–Mn–Zr, design for fuel element canning, 17: 16730(P)
Nb–Ti–Zr, fabrication of high-quality tubing of, 17: 16603 (ANL-FGF-409)
Nb–W–Zr, phase equilibria of niobium-rich regions, 17: 16641(R) (DRI-2091)
Nb–Zr, corrosion of, in water at 680°F and steam at 750 and 900°F, 17: 16586 (GEAP-4098)
Nb–Zr, corrosion of, by rubidium at 1000 to 2000°F, 17: 16634 (AGN-8063)
Nb–Zr, preparation of powders of, by igneous electrolysis, 17: 16529(T,R) (EURAEC-509)
Nb–Zr, properties as claddings for uranium carbide fuels, 17: 16650 (NAA-SR-7696)
Nb–Zr, properties of superconducting at 9,250 Mcps, 17: 16722
Nb–Zr, radiation effects, 17: 17447
Nb–Zr, superconductive properties and technical applications of, 17: 16705
Nb–Zr, thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
Pu–Zr, chemistry and metallurgy of, 17: 17439
Pu–Zr, phase studies, 17: 16566

Pu–Zr, radiation effects on, 17: 16572
Sb–Ge–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Sb–Nb–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
U–Zr, analysis of, for zirconium, 17: 15892
Zr–Pu, phase diagram, 17: 16567

ZIRCONIUM BORIDES
emissivity, measurement of spectral, 17: 16632(R) (AD-274654)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)

ZIRCONIUM CARBIDES
preparation and properties of, for use in industry, 17: 15989
radiation and temperature effects on mechanical and physical properties of, 17: 16760
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
UC–ZrC, cathode vapor loss of, physical and chemical redeposition methods for reduction of, 17: 16774(R) (GA-3642)
UC–ZrC, electron emission and vaporization, 17: 16516(R) (GA-3866)

ZIRCONIUM CHLORIDES
preparation and properties of, for use in industry, 17: 15989
preparation of labeled by slowing down of fission fragments in chlorine-containing gases, 17: 16065
reduction of, by magnesium or sodium, preparation of zirconium by, 17: 16615

ZIRCONIUM COMPLEXES
spectra of, absorption, 17: 15927

ZIRCONIUM COMPOUNDS
organic, preparation and properties of, for use in industry, 17: 15989

ZIRCONIUM FLUORIDES
preparation and properties of, for use in industry, 17: 15989

ZIRCONIUM HYDRIDES
development as reactor moderator material, 17: 17445

ZIRCONIUM ISOTOPES Zr-90
mass difference from strontium-88, 17: 17158
photon reactions (γ,n) on, threshold of, 17: 17158

ZIRCONIUM ISOTOPES Zr-97
production in helium ion fission of uranium-235 and -238, cross sections for, 17: 17126 (TID-18165)
reactions with chlorine in gas mixtures, 17: 16065

ZIRCONIUM NITRIDES
emissivity, measurement of spectral, 17: 16632(R) (AD-274654)
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)

ZIRCONIUM ORES
separation of hafnium and zirconium from oxide, 17: 16533

ZIRCONIUM OXIDE FILMS
stresses in, measurements of, 17: 16685

ZIRCONIUM OXIDES
electric conductivity of stabilized, at 550 to 1200°C, 17: 16683
fission gas release from irradiated, 17: 15532(R) (BMI-1607(Del.))
phase inversion of, 17: 15973
phase transformation hysteresis, 17: 16667
phase transformations at 1155°C, x-ray analysis of time dependence of, 17: 16750
preparation and properties of, for use in industry, 17: 15989
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)
$MgO–ZrO_2$, phase boundaries of cubic solid solutions of, 17: 15974
$MgO–ZrO_2$, phase boundaries of cubic solid solutions at 1400 to 2285°C, 17: 15975
$UO_2–ZrO_2$, fabrication, 17: 15532(R) (BMI-1607(Del.))

ZIRCONIUM PHOSPHATES
ion exchange properties at high temperatures, 17: 15865
sorptive properties for cesium-137, 17: 16139 (AERE-R-4245)

ZIRCONIUM SILICATES
thermal properties of, at 500 to 5000°F, 17: 16636 (ASD-TDR-62-765)

ZIRCONIUM SULFATES
preparation and properties of, for use in industry, 17: 15989

ZIRCONIUM SYSTEMS
C–Nb–Ta–V–Zr, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
C–Nb–Zr–V, preparation and properties of dispersion strengthened, 17: 16514(R) (ARF-B6007-1)
Cr–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Nb–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Sb–Te–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)
Te–Sn–Zr, corrosion of, in 680°F water, 17: 16582 (ARF-B198-36)

ZIRCONS
ratio of hafnium oxide to zirconium oxide in, from Vishnevye and Ilmenskie Mountains, 17: 16275

ZIRFLEX PROCESS
construction materials for, corrosion behavior of, 17: 17451

REPORT NUMBER INDEX

All reports, translations, and patents abstracted in this issue are included in this index. Each item is listed by report number; this is followed by the abstract number and a brief notation regarding public availability. The index entries show, when known, which reports are on file in the depository libraries, which reports have been published in open-literature journals (journal citation given), and which reports can be purchased (source and price). Whenever a report is identified by more than one number, cross references from secondary to primary report numbers are cited.

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6373	17-16848	Phys. Rev. 130: 211-22(1963)
6374	17-15734	Radiation Botany 2: 265-71(1962)
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2213	17-16772	Dep.(mc)
2226	17-15874	Dep.(mc)
2238	17-15946	Dep.(mc)
CEA-tr–	**(French)**	
A-1194	17-17600	Dep.(mc); $2.60(fs), $0.95(mf) JCL
A-1230	17-16149	Dep.(mc); $1.10(fs), $0.80(mf) JCL
A-1245	17-15891	Dep.(mc); $1.60(fs), $0.80(mf) JCL
A-1291	17-16150	Dep.(mc); $2.60(fs), $0.98(mf) JCL
CEND–	**(Misc.)**	
173	17-16605	Dep.(mc); $2.60(fs), $0.89(mf) OTS
CERN–	**(European Organization for Nuclear Research)**	
62-34	17-17311	Dep.(mc)
62-36	17-16944	Dep.(mc)
CISE-R–	**(Italian)**	
70	17-17406	See EURAEC-519
71	17-17407	See EURAEC-537
CRB–	**(Canadian)**	
1129	17-15627	Dep.; $1.50(AECL)
CRCE–	**(Canadian)**	
1131	17-15849	Dep.; $0.50(AECL)
CRER–	**(Canadian)**	
1068	17-15587	Dep.; $0.50(AECL)
CRP–	**(Canadian)**	
615(Rev.)	17-17104	Dep.; $6.00(AECL)
CRT–	**(Canadian)**	
1088	17-17089	Dep.; $1.00(AECL)
CVNA–	**(Misc.)**	
159	17-16734	Dep.(mc); $7.60(fs), $2.54(mf) OTS
DESY-A–	**(German)**	
2.96	17-17105	Dep.(mc)
DLCS–		
5000163	17-17534	Dep.(mc); $5.60(fs), $1.85(mf) OTS
DMIC-Memo–	**(Non-AEC)**	
157	17-16639	$1.00(OTS)
164	17-16640	$1.00(OTS) as AD-298204
165	17-16515	
DP–		
261	17-16489	Dep.(mc); $8.10(fs), $2.63(mf) OTS
600	17-17592	Dep.; $3.50(OTS)
732	17-16490	Dep.; $0.75(OTS)
757	17-16140	Dep.; $1.25(OTS)
817	17-17106	Dep.; $1.25(OTS)
DRI–	**(Misc.)**	
2088	17-15947	Dep.(mc); $1.60(fs), $0.80(mf) OTS
2091	17-16641	Dep.(mc); $1.10(fs), $0.80(mf) OTS
DUBNA REPORTS	**(Russian)**	
See JINR (Russian)		
EDR–	**(Non-AEC)**	
3207	17-16773	
EFINS–	**(Misc.)**	
62-46	17-17025	Phys. Rev. 130: 319-26(1963)
62-64	17-17032	Phys. Rev. 130: 424-8(1963)
EGCR-STUDY-II–		

Report No.	Abstract No.	Availability
100	17-17547	See TID-18095
104-1	17-17549	See TID-18097
105-1	17-17566	See TID-18245
105-2	17-17554	See TID-18106
105-3	17-17564	See TID-18243
105-4	17-17548	See TID-18096
129	17-17552	See TID-18101
151	17-17553	See TID-18102
175	17-17567	See TID-18247
179-1	17-17568	See TID-18248
180	17-17561	See TID-18240
200	17-17563	See TID-18242
204	17-17562	See TID-18241
207	17-17530	See ACNP-62509
225	17-17560	See TID-18239
226	17-17550	See TID-18098
226(Suppl. 1)	17-17559	See TID-18238
227	17-17571	See TID-18251
227-A	17-16659	See TID-18246
229	17-17558	See TID-18237
231	17-17565	See TID-18244
233	17-17551	See TID-18099
240	17-17557	See TID-18235
242	17-17569	See TID-18249
249	17-17570	See TID-18250
EIR–	**(Swiss)**	
41	17-15628	Dep.(mc)
ER–	**(Misc.)**	
5185*	17-16633	See AD-296341
6102*	17-16742	See NP-12628
EURAEC–		
29	17-16594	Dep.(mc); $4.60(fs), $1.64(mf) OTS
126	17-16528	Dep.(mc); $1.60(fs), $0.80(mf) OTS
292	17-16313	Dep.(mc); $1.10(fs), $0.80(mf) OTS
363	17-16665	Dep.(mc); $2.60(fs), $0.92(mf) OTS
509	17-16529	Dep.(mc); $3.61(fs), $1.31(mf) OTS
514	17-16738	See GEAP-4081
518	17-17620	Dep.(mc); $3.60(fs), $1.28(mf) OTS
519	17-17406	Dep.(mc); $1.60(fs), $0.80(mf) OTS
522	17-16610	Dep.(mc); $2.60(fs), $0.83(mf) OTS
523	17-16237	Dep.(mc); $1.60(fs), $0.80(mf) OTS
524	17-16642	Dep.(mc); $2.60(fs), $0.92(mf) OTS
528	17-17539	See GEAP-4164
531	17-16522	See NCSC-2663-10
533	17-17412	See GNEC-264
537	17-17407	Dep.(mc); $1.60(fs), $0.80(mf) OTS
545	17-16583	Dep.(mc); $1.60(fs), $0.80(mf) OTS
548	17-16643	Dep.(mc); $1.10(fs), $0.80(mf) OTS
550	17-16584	Dep.(mc); $1.60(fs), $0.80(mf) OTS
551	17-16611	Dep.(mc); $1.60(fs), $0.80(mf) OTS
552	17-16595	Dep.(mc); $11.00(fs), $4.43(mf) OTS
554	17-16582	See ARF-B198-36
559	17-16596	Dep.(mc); $1.10(fs), $0.80(mf) OTS
561	17-16644	Dep.(mc); $ 4.60(fs), $1.67(mf) OTS
568	17-16645	Dep.(mc); $1.60(fs), $0.80(mf) OTS
569	17-16585	Dep.(mc); $2.60(fs), $1.01(mf) OTS
575	17-16605	See CEND-173
582	17-16638	See BMI-1611
584	17-17408	Dep.(mc); $1.10(fs), $0.80(mf) OTS
EXP-NRX–	**(Canadian)**	
2807	17-16735	Dep.; $1.00(AECL)
FFIS-IR–	**(Norwegian)**	
S-15	17-15614	See A/AC.82/G/L.810
FN-E–	**(Italian)**	
30	17-16645	See EURAEC-568
31	17-17408	See EURAEC-584
GA–	**(Misc.)**	
3069	17-17107	Dep.; $2.00(OTS)
3298	17-17090	Dep.(mc); $2.60(fs), $0.86(mf) OTS
3430	17-17359	Phys. Fluids 6: 398-406(1963)
3604	17-17356	Phys. Fluids 6: 382-8(1963)
3642*	17-16774	
3866*	17-16516	
3872*	17-16736	
GACD–	**(Non-AEC)**	
2813	17-16775	
GAMD–	**(Misc.)**	
927*	17-17324	
1256*	17-16945	
2117*	17-16223	
2237*	17-16224	
2257*	17-16225	
2271*	17-17392	
2288*	17-16776	
3095*	17-16777	
GEAP–	**(Misc.)**	
3811	17-17409	Dep.; $2.75(OTS)
3914	17-17410	Dep.; $2.50(OTS)
3927	17-16737	Dep.; $0.50(OTS)
3967	17-17535	Dep.; $0.75(OTS)
4057	17-17536	Dep.; $3.00(OTS)
4059	17-17537	Dep.; $2.25(OTS)
4081	17-16738	Dep.(mc); $8.60(fs), $3.17(mf) OTS
4098	17-16586	Dep.; $0.50(OTS)
4105	17-17538	Dep.; $2.75(OTS)
4107	17-16739	Dep.(mc); $6.60(fs), $2.18(mf) OTS
4164	17-17539	Dep.(mc); $1.60(fs), $0.80(mf) OTS
4165	17-16587	Dep.(mc); $4.60(fs), $1.61(mf) OTS
GEMP–		
177C	17-17411	Dep.; $1.50(OTS)
192	17-16778	Dep.; $1.00(OTS)
GNEC–		
264	17-17412	Dep.(mc); $8.60(fs), $3.08(mf) OTS
HAG-INJ–	**(Non-AEC)**	
23	17-17328	See NP-12635
HE–	**(Misc.)**	
150-210	17-16260	Dep.(mc); $10.10(fs), $4.10(mf) OTS
HW–		
68442	17-16141	$3.60(fs), $1.19(mf) OTS
74549	17-17413	Dep.; $1.25(OTS)
75626	17-16588	Dep.(mc); $1.10(fs), $0.80(mf) OTS
75731	17-17540	$1.10(fs), $0.80(mf) OTS
76158	17-16740	Dep.; $0.50(OTS)
76228	17-16741	Dep.; $2.75(OTS)
76262	17-17615	Dep.; $1.00(OTS)
76323	17-16357	Dep.; $1.25(OTS)
76363	17-15875	Dep.(mc); $1.60(fs), $0.80(mf) OTS
HW-SA–		
2872	17-16517	Dep.(mc); $3.60(fs), $1.37(mf) OTS
2922	17-17414	$1.60(fs), $0.80(mf) OTS
2933	17-17415	Dep.(mc); $2.60(fs), $0.83(mf) OTS
2945	17-17593	Dep.(mc); $2.60(fs), $0.89(mf) OTS
IDO–		
14596	17-17616	Dep.; $2.00(OTS)
14602	17-16142	Dep.; $0.50(OTS)

Report No.	Abstract No.	Availability
16823	17-16382	Dep.; $0.50(OTS)
16830	17-17416	Dep.; $2.25(OTS)
28602	17-17541	Dep.; $2.25(OTS)
IOI-	**(Canadian)**	
158	17-17594	Dep.; $1.50(AECL)
IS-		
522	17-17312	Dep.; $2.00(OTS)
ISS-	**(Italian)**	
62/4	17-16422	Dep.(mc)
62/9	17-16423	Dep.(mc)
62/10	17-16424	Dep.(mc)
62/11	17-16425	Dep.(mc)
62/15	17-16946	Dep.(mc)
62/17	17-16779	Dep.(mc)
62/21	17-17108	Dep.(mc)
62/23	17-16780	Dep.(mc)
62/24	17-16947	Dep.(mc)
62/26	17-16426	Dep.(mc)
62/27	17-17109	Dep.(mc)
62/28	17-17110	Dep.(mc)
62/29	17-17111	
62/30	17-17112	Dep.(mc)
JEN-	**(Spanish)**	
73-SI/18	17-16358	Dep.(mc)
81-DMe/16	17-16606	Dep.(mc)
JINR-	**(Russian)**	
D-1128	17-16948	Dep.(mc)
E-1154	17-17113	Dep.(mc)
E-1156	17-16949	Dep.(mc)
P-1135	17-16950	Dep.(mc)
P-1148	17-17114	Dep.(mc)
P-1150	17-16951	Dep.(mc)
P-1153	17-17115	Dep.(mc)
P-1157	17-17116	Dep.(mc)
P-1159	17-16781	Dep.(mc)
P-1160	17-17117	Dep.(mc)
P-1161	17-16952	Dep.(mc)
P-1162	17-17118	Dep.(mc)
P-1163	17-16953	Dep.(mc)
P-1164	17-17119	Dep.(mc)
JPL-TR-	**(Non-AEC)**	
32-233	17-17603	$1.60(fs), $0.80(mf) OTS
JPRS-	**(Non-AEC)**	
18020	17-15647	$0.50(OTS)
18153	17-15805	$0.50(OTS)
18277	17-16530	$0.50(OTS)
18391	17-15616	$0.50(OTS)
JUL-	**(German)**	
88-PP	17-16383	Dep.(mc)
99-PP	17-16782	Dep.(mc)
KAPL-M-		
JVM-4	17-16173	Dep.(mc); $7.60(fs), $2.42(mf) OTS
KR-	**(Norwegian)**	
35(Vol.I)	17-17417	Dep.(mc)
35(Vol.II)	17-17418	Dep.(mc)
41	17-17595	Dep.(mc)
LA-		
2327	17-17596	Supplemented by LA-2833
2833	17-17596	Dep.; $2.50(OTS)
2836	17-15948	Dep.; $0.50(OTS)
2844	17-15876	Dep.; $0.50(OTS)
LADC-		
3123	17-16569	p.333-9 of "The Metal Plutonium." Chicago, The University of Chicago Press, 1961
5128	17-16783	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5209	17-15588	Dep.(mc); $3.60(fs), $1.13(mf) OTS
5278	17-15629	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5310	17-16226	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5330	17-16646	Dep.(mc); $2.60(fs), $0.89(mf) OTS
5343	17-16314	$4.60(fs), $1.46(mf) OTS
5359	17-16315	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5363	17-16647	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5366	17-17617	Dep.(mc); $3.60(fs), $1.28(mf) OTS
5373	17-16648	Dep.(mc); $2.60(fs), $1.01(mf) OTS
5374	17-15949	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5377	17-16143	Dep.(mc); $2.60(fs), $0.83(mf) OTS
5380	17-16518	Dep.(mc); $3.60(fs), $1.22(mf) OTS
5383	17-17091	Dep.(mc); $8.10(fs), $2.63(mf) OTS
5396	17-16649	Dep.(mc); $2.60(fs), $1.04(mf) OTS
5401	17-15630	Dep.(mc); $2.60(fs), $0.92(mf) OTS
5410	17-16316	Dep.(mc); $4.60(fs), $1.55(mf) OTS
5418	17-16174	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5456	17-16922	J. Geophys. Res. 68: 1221-8(1963)
5512	17-17024	Phys. Rev. 130: 272-5(1963)
5562	17-17236	Phys. Rev. 130: 292-8(1963)
5566	17-15950	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5579	17-15951	Dep.(mc); $1.10(fs), $0.80(mf) OTS
5679	17-16384	Dep.(mc); $1.60(fs), $0.80(mf) OTS
5711	17-15952	Dep.(mc); $5.60(fs), $1.73(mf) OTS
LAL-	**(French)**	
1029	17-17120	Dep.(mc)
LAMS-		
2799	17-16175	Dep.; $3.60(fs), $1.34(mf) OTS
2845	17-16504	Dep.; $12.50(fs), $5.45(mf) OTS
LM-TAB-	**(Non-AEC)**	
21	17-16519	
LNF-	**(Italian)**	
62/95	17-17313	Dep.(mc)
62/102	17-17121	Dep.(mc)
MAB-	**(Non-AEC)**	
189-M	17-16520	
MATT-		
130	17-17325	Dep.(mc); $3.60(fs), $1.16(mf) OTS
133	17-17326	Dep.; $1.00(OTS)
141	17-17362	Phys. Fluids 6: 422-5(1963)
MITNE-	**(Misc.)**	
26	17-17419	Dep.; $1.75(OTS)
ML-	**(Misc.)**	
874*	17-17327	
947*	17-17605	See N62-11311
MMPP-	**(Misc.)**	
226-1	17-15877	Dep.(mc); $7.60(fs), $2.36(mf) OTS
MTI-	**(Misc.)**	
62TR38	17-16660	See TID-18252
MURA-	**(Misc.)**	
654	17-17314	Dep.; $2.50(OTS)
N-	**(Misc.)**	

Report No.	Abstract No.	Availability
62-11122*	17-17604	$8.10(fs), $2.90(mf) OTS
62-11254*	17-16632	See AD-274654
62-11311*	17-17605	$2.60(fs), $0.98(mf) OTS
62-11503*	17-17603	See JPL-TR-32-233
NAA-SR–		
3740	17-17542	Dep.(mc); $2.60(fs), $1.04(mf) OTS
7263	17-16940	Dep.; $0.50(OTS)
7696	17-16650	Dep.; $0.75(OTS)
7786	17-17420	Dep.; $1.00(OTS)
NAA-SR-Memo–		
477	17-17421	Dep.(mc); $1.10(fs), $0.80(mf) OTS
1522	17-16651	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2974	17-16521	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7521(Rev.)	17-17543	Dep.(mc); $1.10(fs), $0.80(mf) OTS
7789	17-17422	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7804	17-17597	Dep.(mc); $5.60(fs), $1.97(mf) OTS
7945	17-16227	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7952	17-17544	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7955	17-16176	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8053	17-17545	Dep.(mc); $2.60(fs), $0.92(mf) OTS
8064	17-16228	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8088	17-17423	Dep.(mc); $1.60(fs), $0.80(mf) OTS
8151	17-16317	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NASA-TN–	**(Misc.)**	
D-1523*	17-15953	$4.00(OTS)
D-1578*	17-17606	$0.75(OTS)
NASA-TR–	**(Non-AEC)**	
R-161	17-16784	
NC–	**(Norwegian)**	
38	17-17555	See TID-18108
NCSC–	**(Misc.)**	
2477-10	17-16041	Dep.; $2.50(OTS)
2663-10	17-16522	Dep.(mc); $2.60(fs), $0.86(mf) OTS
NDA–	**(Misc.)**	
2154-5	17-15878	Dep.(mc); $1.60(fs), $0.80(mf) OTS
NLCO–		
867	17-16144	Dep.; $0.50(OTS)
NRL–	**(Misc.)**	
1254	17-16589	Dep.(mc); $7.60(fs), $2.33(mf) OTS
4950	17-16607	Dep.(mc); $8.10(fs), $2.66(mf) OTS
NP–	**(AEC File No. for Non-AEC Reports)**	
12457	17-16385	Dep.(mc)
12596	17-16359	
12597	17-16360	
12598	17-16361	
12599	17-16362	
12600	17-16363	
12601	17-15631	
12602	17-16364	
12603	17-16365	
12604	17-16366	
12605	17-16367	
12606	17-16368	
12607	17-16369	
12608	17-16370	
12609	17-16371	
12611	17-17393	
12615	17-16608	
12628	17-16742	
12629	17-16318	
12631	17-16229	
12632	17-16523	
12633	17-16652	
12634	17-16653	
12635	17-17328	Dep.(mc)
12644	17-16954	
12645	17-15533	Dep.(mc)
NP-tr–	**(AEC File No. for Non-AEC Translations)**	
958	17-15966	Dep.(mc); $1.10(fs), $0.80(mf) JCL
NPCC-FEWP–	**(British)**	
P.1118	17-16661	See TRG-Report-441
NUMEC-P–		
103	17-16524	Dep.(mc); $4.60(fs), $1.52(mf) OTS
NYO–		
3062	17-16785	Dep.(mc); $4.60(fs), $1.43(mf) OTS
9674	17-16319	Dep.(mc); $3.60(fs), $1.19(mf) OTS
9675	17-16320	Dep.(mc); $6.60(fs), $2.09(mf) OTS
9736	17-16525	Dep.(mc); $4.60(fs), $1.64(mf) OTS
9801	17-16183	Dep.(mc); $4.60(fs), $1.67(mf) OTS
10208	17-17419	See MITNE-26
10214	17-16609	Dep.(mc); $3.60(fs), $1.28(mf) OTS
10238	17-16955	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10239	17-16956	Dep.(mc); $2.60(fs), $0.95(mf) OTS
10250	17-16786	Dep.(mc); $16.00(fs), $7.61(mf) OTS
ORA–	**(Misc.)**	
04653-2-P	17-16231	See TID-15719
04997-1-P	17-15887	See TID-18204
ORNL–		
3312	17-16145	Dep.; $3.60(fs), $1.19(mf) OTS
3392	17-17329	Dep.; $2.25(OTS)
3397	17-15850	Dep.; $2.75(OTS)
3398	17-16654	Dep.; $2.60(fs), $0.95(mf) OTS
3399	17-16505	Dep.; $0.75(OTS)
3401	17-16321	Dep.; $2.00(OTS)
ORNL-TM–		
263	17-17618	Dep.(mc); $1.60(fs), $0.80(mf) OTS
481	17-16526	Dep.(mc); $2.60(fs), $0.86(mf) OTS
482	17-17619	Dep.(mc); $8.10(fs), $2.90(mf) OTS
514	17-16957	Dep.(mc); $1.10(fs), $0.80(mf) OTS
524	17-17315	Dep.(mc); $1.60(fs), $0.80(mf) OTS
527	17-16146	Dep.(mc); $3.60(fs), $1.37(mf) OTS
ORO–		
199	17-16264	Dep.; $1.50(OTS)
584	17-15632	$1.10(fs), $0.80(mf) OTS
598	17-15541	Dep.; $2.50(OTS)
OTS–	**(Misc.)**	
63-21277*	17-15647	For translation see JPRS-18020
63-21332*	17-15805	For translation see JPRS-18153
63-21384*	17-16530	For translation see JPRS-18277
63-21435*	17-15616	For translation see JPRS-18391
P–	**(Misc.)**	
1951(RAND)*	17-16330	
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
915,718	17-16198	
915,939	17-16199	
917,046	17-16472	
917,198	17-16254	
917,278	17-17474	
917,592	17-16200	
917,929	17-16201	
918,379	17-16202	

Report No.	Abstract No.	Availability
918,586	17-16203	
918,649	17-16204	
918,666	17-16205	
918,741	17-17390	
918,839	17-17584	
918,880	17-16617	
918,883	17-16473	
918,894	17-16206	
918,907	17-17475	
919,171	17-17476	
919,188	17-16112	
919,191	17-17477	
919,192	17-16474	
919,319	17-16730	
919,331	17-16255	
919,356	17-16207	
919,423	17-16618	
919,514	17-16256	
919,523	17-16127	
919,637	17-17585	
919,643	17-16355	
919,672	17-16029	
919,683	17-16113	
919,810	17-17478	
919,822	17-17479	
919,823	17-16114	
919,866	17-17480	
919,876	17-16494	
919,956	17-16208	
919,986	17-17481	
920,113	17-16167	
920,128	17-16731	
920,167	17-17482	
920,198	17-17586	
920,200	17-17483	
920,256	17-17484	
920,274	17-17485	
920,343	17-17486	
920,509	17-16764	
920,531	17-17487	
920,576	17-17488	
920,577	17-17489	
920,689	17-16475	
920,735	17-15866	
920,795	17-16577	
920,847	17-17490	
920,862	17-15867	
921,100	17-16395	
921,215	17-16396	
921,236	17-16578	
921,281	17-16209	
921,288	17-17491	
921,348	17-17492	
921,350	17-16495	
921,366	17-16496	
921,397	17-16397	
921,434	17-17493	
921,447	17-17494	
921,448	17-17587	
921,476	17-16398	
921,484	17-16579	
921,491	17-16476	
921,654	17-16128	
921,655	17-16129	
921,660	17-17495	
921,699	17-17496	
921,710	17-17497	
921,711	17-16210	
921,770	17-16211	
921,774	17-17498	
921,775	17-16212	

Report No.	Abstract No.	Availability
PATENTS	**(Canadian)**	
649,259	17-17499	
649,299	17-16257	
650,296	17-17500	
650,606	17-16213	
650,712	17-16258	
651,597	17-16399	
651,598	17-16400	
651,599	17-16401	
652,867	17-17501	
653,170	17-16130	
653,172	17-17502	
653,533	17-16402	
653,803	17-16619	
653,910	17-17503	
654,762	17-17504	
655,091	17-16477	
655,162	17-16214	
655,231	17-16030	
655,287	17-16131	
655,462	17-16620	
655,587	17-16478	
656,692	17-16215	
656,855	17-16497	
PATENTS	**(French)**	
1,218,482	17-17505	
1,231,675	17-17506	
1,238,281	17-17507	
1,261,526	17-17508	
1,264,209	17-16621	
1,267,860	17-16622	
1,269,742	17-16498	
1,271,235	17-16216	
1,271,794	17-16623	
1,273,988	17-16499	
1,276,460	17-16624	
1,281,809	17-17509	
1,283,560	17-16625	
1,284,135	17-16626	
1,285,735	17-16627	
PATENTS	**(German)**	
21374	17-17588	
1,128,057	17-17510	
1,139,216	17-17511	
1,139,217	17-17512	
1,141,391	17-17513	
1,141,733	17-16261	
1,142,038	17-16479	
1,142,040	17-16217	
1,142,041	17-17514	
1,142,344	17-16500	
1,142,367	17-16259	
1,142,423	17-17515	
1,142,445	17-16580	
1,142,710	17-16403	
1,142,852	17-16132	
1,142,945	17-16404	
1,142,972	17-17516	
1,143,278	17-17517	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,074,866	17-16115	
3,074,867	17-16116	
3,074,872	17-17518	
3,074,873	17-17519	
3,074,874	17-17520	
3,074,875	17-17391	
3,074,880	17-16117	

Report No.	Abstract No.	Availability
3,075,076	17-15935	
3,075,077	17-16405	
3,075,081	17-16480	
3,075,116	17-16481	
3,075,154	17-16406	
3,075,904	17-16118	
3,075,905	17-16119	
3,075,906	17-16120	
3,075,909	17-16218	
3,075,910	17-17521	
3,076,093	17-16482	
3,076,094	17-16483	
3,076,753	17-17522	
3,076,789	17-16039	
3,076,894	17-16407	
3,076,895	17-16484	
3,078,141	17-16133	
3,078,142	17-16168	
3,078,370	17-16408	
3,078,412	17-16409	
3,079,315	17-17589	
3,079,316	17-16628	
3,079,319	17-17523	
3,079,320	17-17524	
3,079,322	17-17525	
3,079,324	17-16134	
3,079,499	17-16485	
3,079,501	17-16486	
3,080,262	17-15868	
3,080,306	17-16765	
3,080,307	17-17526	
3,080,309	17-17590	
3,080,323	17-15869	
3,080,478	17-16410	
3,080,479	17-16411	
3,080,480	17-16412	
3,080,481	17-16629	
3,080,482	17-16413	
3,080,519	17-16908	
3,080,527	17-16909	
3,081,147	17-16135	
3,081,148	17-16136	
3,081,149	17-16137	
3,081,156	17-16501	
3,081,243	17-16121	
3,081,244	17-16122	
3,081,246	17-17527	
3,081,248	17-17528	
3,081,249	17-16630	
3,081,401	17-16414	
3,082,045	17-16219	
3,082,158	17-15870	
3,082,161	17-16766	
3,082,162	17-16581	
3,082,314	17-16220	
3,082,316	17-16631	
3,082,322	17-16221	
3,082,323	17-16487	
3,082,325	17-16488	
3,082,326	17-16415	
PATENTS	**(U.S.S.R.)**	
149,155	17-16436	
PG-REPORT	**(British)**	
276	17-15879	Dep.; $0.31(BIS); 2s. 3d. (HMSO)
352	17-15954	Dep.; $0.70(BIS); 1s. 6d. (HMSO)
393	17-15880	Dep.
409	17-15881	Dep.; $0.28(BIS); 2s. (HMSO)
418	17-15882	Dep.; $0.21(BIS), 1s. 6d. (HMSO)
428	17-15883	Dep.; $0.21(BIS); 1s. 6d. (HMSO)

Report No.	Abstract No.	Availability
PNE–		
111F	17-16265	Dep.; $2.00(OTS)
PPAD–		
461E	17-16427	Dep.(mc); $1.60(fs), $0.80(mf) OTS
PRDC-TR–		
62	17-17424	Dep.(mc); $1.60(fs), $0.80(mf) OTS
PUC–		
1962-78	17-17122	Dep.(mc); $4.60(fs), $1.52(mf) OTS
PWA–	**(Non-AEC)**	
2132	17-16230	
2163	17-16787	
PWAC–	**(Misc.)**	
378	17-15955	Dep.; $1.25(OTS)
Q–		
A2392-3-7	17-16182	See TID-18292
R–	**(Misc.)**	
2199	17-16583	See EURAEC-545
2202	17-16584	See EURAEC-550
2203	17-16643	See EURAEC-548
2204	17-16642	See EURAEC-524
58AGT967*	17-16788	
63SD16*	17-17339	
RED-EPM–		
114	17-16429	See TID-18304
RFP–		
63	17-16941	Dep.(mc); $1.60(fs), $0.80(mf) OTS
RM–	**(Misc.)**	
3224-AEC	17-17373	Phys. Rev. 129: 2376-97(1963)
3256-PR*	17-17425	$3.60(OTS)
SAM-TDR–	**(Non-AEC)**	
62-85	17-15803	
62-103	17-15633	$1.60(OTS)
SB–	**(Non-AEC)**	
62-62	17-16655	
SC–	**(Misc.)**	
4764(RR)	17-16177	Dep.; $1.25(OTS)
SCDC–		
2744	17-16232	See TID-16555
2829	17-16884	See TID-17079
SCL-T–		
468	17-15967	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
SCTM–		
251-62(24)	17-16506	Dep.(mc); $2.60(fs), $0.98(mf) OTS
SIT-P–	**(Misc.)**	
85	17-16790	See TID-18216
SLAC–		
7	17-17316	Dep.; $2.00(OTS)
8	17-17317	Dep.; $2.00(OTS)
9	17-17318	Dep.; $2.25(OTS)
SRO–		
78	17-16042	Dep.; $0.90(OTS)
80	17-17546	Dep.(mc); $1.60(fs), $0.80(mf) OTS

Report No.	Abstract No.	Availability
STI-PUB–	(International Atomic Energy Agency)	
15/27	17-15800	Review Series No. 27 of "Developments in the Peaceful Applications of Nuclear Energy," $1.00(IAEA)
60	17-15762	Proceedings of the Symposium Held at Brno, 2/6 July, 1962, $9.00(IAEA)
67	17-17302	Lectures Given at the International Summer School in the Low Tatra Mountains, August 20–September 8, 1962. $10.00(IAEA)
TID–		
3522(Rev.6)	17-15534	Dep.; $1.25(OTS)
6011	17-16536	J. Nucl. Mater. 7: 125-32(1962)
12616(Rev.1)	17-16331	Dep.; $1.00(OTS)
15719	17-16231	Dep.(mc); $3.60(fs), $1.34(mf) OTS
15964	17-15634	Dep.(mc); $3.60(fs), $1.28(mf) OTS
16340	17-15956	Dep.(mc); $2.60(fs), $0.86(mf) OTS
16387	17-15957	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16475	17-16656	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16476	17-15958	Dep.(mc); $2.60(fs), $1.07(mf) OTS
16483	17-16913	See TID-17961
16485	17-17092	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16506	17-16657	Dep.(mc); $4.60(fs), $1.58(mf) OTS
16522	17-15884	Dep.(mc); $1.60(fs), $0.80(mf) OTS
16555	17-16232	Dep.(mc); $3.60(fs), $1.37(mf) OTS
16909	17-15998	J. Electrochem. Soc. 110: 346-9(1963)
17034	17-17220	Phys. Rev. 129: 2679-83(1963)
17079	17-16884	Trans. Nucl. Sci. NS-10: 88-96(1963)
17267	17-17208	Phys. Rev. 129: 2371-5(1963)
17275	17-16031	Dep.(mc); $3.60(fs), $1.13(mf) OTS
17285	17-17218	Phys. Rev. 129: 2653-9(1963)
17299	17-17235	Phys. Rev. 130: 265-71(1963)
17301	17-17234	Phys. Rev. 130: 259-64(1963)
17385	17-17426	Dep.; $0.50(OTS)
17455	17-16015	Phys. Rev. 129: 2460-4(1963)
17682	17-16743	Dep.; $2.25(OTS)
17762	17-15635	Dep.; $0.75(OTS)
17784	17-17022	Phys. Rev. 129: 2816-17(1963)
17794	17-17230	Phys. Rev. 129: 2808-11(1963)
17887	17-16178	Dep.; $2.00(OTS)
17940	17-16592	Dep.; $0.50(OTS)
17947	17-17441	(Euratom). $5.00 per yr.
17961	17-16913	J. Geophys. Res. 68: 1555-7(1963)
18058	17-15589	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18061	17-15636	Dep.(mc); $2.60(fs), $0.95(mf) OTS
18064	17-16942	Dep.(mc); $3.60(fs), $1.22(mf) OTS
18074	17-16179	Dep.(mc); $3.60(fs), $1.25(mf) OTS
18092	17-16094	Radiation Effects on Organic Materials. New York, Academic Press, 1963
18094	17-16043	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18095	17-17547	Dep.(mc); $4.60(fs), $1.67(mf) OTS
18096	17-17548	Dep.(mc); $3.60(fs), $1.31(mf) OTS
18097	17-17549	Dep.(mc); $7.60(fs), $2.33(mf) OTS
18098	17-17550	Dep.(mc); $8.10(fs), $2.75(mf) OTS
18099	17-17551	Dep.(mc); $6.60(fs), $2.30(mf) OTS
18101	17-17552	Dep.(mc); $3.60(fs), $1.25(mf) OTS
18102	17-17553	Dep.(mc); $2.60(fs), $0.83(mf) OTS
18106	17-17554	Dep.(mc); $2.60(fs), $0.86(mf) OTS
18108	17-17555	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18112	17-16744	Dep.(mc); $3.60(fs), $1.13(mf) OTS
18115	17-17340	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18116	17-16507	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18117	17-17093	$5.60(fs), $1.88(mf) OTS
18119	17-15885	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18121	17-17598	Dep.(mc); $2.60(fs), $0.98(mf) OTS
18124	17-16372	Dep.; $0.75(OTS)
18125	17-15886	Dep.; $0.75(OTS)
18127	17-17123	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18131	17-17124	Dep.(mc); $12.00(fs), $5.71(mf) OTS
18135	17-15637	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18137	17-17125	Dep.(mc); $2.60(fs), $1.04(mf) OTS
18138	17-15542	Dep.(mc); $3.60(fs), $1.16(mf) OTS
18139	17-15638	Dep.(mc); $2.60(fs), $0.92(mf) OTS
18140	17-15959	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18141	17-16233	$1.60(fs), $0.80(mf) OTS
18142	17-16032	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18144	17-16044	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18145	17-16789	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18146	17-15960	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18149	17-16033	Dep.(mc); $2.60(fs), $1.10(mf) OTS
18150	17-16745	Dep.(mc); $5.60(fs), $1.85(mf) OTS
18153	17-16428	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18159	17-15934	To be published in TID-7655, Proceedings of the 6th Conference on Analytical Chemistry in Nuclear Reactor Technology, held in Gatlinburg, Tenn., 1962
18161	17-15590	Dep.(mc); $8.10(fs), $2.90(mf) OTS
18162	17-16386	Dep.(mc); $2.60(fs), $1.07(mf) OTS
18165	17-17126	Dep.(mc); $4.60(fs), $1.46(mf) OTS
18170	17-16034	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18184	17-16045	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18194	17-15639	Dep.(mc); $7.60(fs), $2.54(mf) OTS
18197	17-16658	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18198	17-15961	$1.60(fs), $0.80(mf) OTS
18199	17-15962	$1.60(fs), $0.80(mf) OTS
18200	17-15963	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18203	17-15640	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18204	17-15887	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18216	17-16790	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18221	17-15641	Dep.(mc); $5.60(fs), $1.79(mf) OTS
18223	17-17319	Dep.(mc); $2.60(fs), $0.98(mf) OTS
18225	17-17341	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18229	17-17556	Dep.(mc); $4.60(fs), $1.43(mf) OTS
18231	17-16791	Dep.(mc); $2.60(fs), $1.10(mf) OTS
18233	17-16180	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18234	17-17427	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18235	17-17557	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18236	17-16508	Dep.(mc); $4.60(fs), $1.49(mf) OTS
18237	17-17558	Dep.(mc); $11.00(fs), $4.58(mf) OTS
18238	17-17559	Dep.(mc); $5.60(fs), $1.73(mf) OTS
18239	17-17560	Dep.(mc); $2.60(fs), $0.86(mf) OTS
18240	17-17561	Dep.(mc); $3.60(fs), $1.34(mf) OTS
18241	17-17562	Dep.(mc); $3.60(fs), $1.13(mf) OTS
18242	17-17563	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18243	17-17564	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18244	17-17565	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18245	17-17566	$3.60(fs), $1.13(mf) OTS
18246	17-16659	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18247	17-17567	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18248	17-17568	Dep.(mc); $2.60(fs), $1.07(mf) OTS
18249	17-17569	Dep.(mc); $3.60(fs), $1.13(mf) OTS
18250	17-17570	Dep.(mc); $3.60(fs), $1.19(mf) OTS
18251	17-17571	$17.50(fs), $8.48(mf) OTS
18252	17-16660	Dep.(mc); $2.60(fs), $1.01(mf) OTS
18253	17-16746	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18254	17-17599	Dep.(mc); $4.60(fs), $1.43(mf) OTS
18256	17-17127	Dep.(mc); $8.10(fs), $2.90(mf) OTS
18257	17-15888	Dep.(mc); $6.60(fs), $2.15(mf) OTS
18258	17-16792	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18261	17-16046	Dep.(mc); $7.60(fs), $2.51(mf) OTS
18262	17-16057	Dep.(mc); $4.60(fs), $1.49(mf) OTS
18263	17-15964	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18265	17-16793	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18268	17-15642	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18273	17-15965	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18277	17-17094	Dep.(mc); $2.60(fs), $1.01(mf) OTS
18283	17-16181	Dep.(mc); $4.60(fs), $1.55(mf) OTS
18292	17-16182	Dep.(mc); $3.60(fs), $1.37(mf) OTS
18304	17-16429	Dep.(mc); $3.60(fs), $1.13(mf) OTS
TM–	(Misc.)	

Report No.	Abstract No.	Availability
62-9-9	17-16745	See TID-18150
TRG-Report–	**(Non-AEC)**	
441	17-16661	Dep.; $0.63(BIS); 4s. 6d. (HMSO)
464	17-16430	Dep.; $0.25(BIS); 1s. 9d. (HMSO)
UAC–		
6691	17-15998	See TID-16909
6860	17-16015	See TID-17455
6970	17-17022	See TID-17784
7096	17-16789	See TID-18145
7108	17-15934	See TID-18159
7110	17-16428	See TID-18153
7126	17-16045	See TID-18184
7127	17-16034	See TID-18170
7137	17-16032	See TID-18142
7138	17-15959	See TID-18140
7165	17-16603	See ANL-FGF-409
UCLA–		
511	17-15543	Dep.(mc); $4.60(fs), $1.43(mf) OTS
UCRL–		
6695	17-17128	Dep.; $3.00(OTS)
6926	17-17129	Dep.(mc); $3.60(fs), $1.25(mf) OTS
6962	17-16286	J. Geophys. Res. 68: 1463-75(1963)
6983	17-17227	Phys. Rev. 129: 2723-9(1963)
7037	17-16842	Phys. Rev. 129: 2581-2(1963)
7059	17-17226	Phys. Rev. 129: 2718-22(1963)
7073	17-16881	Trans. Nucl. Sci. NS-10: 68-73(1963)
7089	17-16879	Trans. Nucl. Sci. NS-10: 36-41(1963)
7115	17-17342	Dep.; $0.50(OTS)
7122	17-17239	Phys. Rev. 130: 309-11(1963)
7143	17-16332	Dep.; $1.25(OTS)
10183	17-17015	Phys. Rev. 129: 2743-54(1963)
10186	17-16071	Nature 197: 895-7(1963)
10306	17-17228	Phys. Rev. 129: 2738-43(1963)
10332	17-16662	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10336	17-16958	Dep.(mc); $1.10(fs), $0.80(mf) OTS
10344	17-16663	Dep.(mc); $1.60(fs), $0.80(mf) OTS
10463	17-17035	Phys. Rev. 130: 442-57(1963)
10523	17-16794	Dep.; $1.00(OTS)
10527	17-16234	Dep.; $2.25(OTS)
10569	17-17041	Phys. Rev. Letters 10: 184-8(1963)
10570	17-17042	Phys. Rev. Letters 10: 188-92(1963)
10579	17-17043	Phys. Rev. Letters 10: 192-6(1963)
10587	17-16918	Dep.; $0.50(OTS)
10599	17-17036	Phys. Rev. Letters 10: 167-70(1963)
10623	17-17040	Phys. Rev. Letters 10: 179-83(1963)
10630	17-17130	Dep.; $1.75(OTS)
13064	17-16664	Dep.(mc); $11.50(fs), $5.00(mf) OTS
13065	17-16260	See HE-150-210
UCRL-Trans–		
904	17-15535	Dep.(mc); $2.60(fs), $0.95(mf) JCL
907(L)	17-16797	Dep.(mc); $3.60(fs), $1.37(mf) JCL
UMC-B–		
63-102	17-16057	See TID-18262
UNC–	**(Misc.)**	
5050	17-15889	Dep.(mc); $2.60(fs), $0.86(mf) OTS
USBM-U–	**(Misc.)**	
1001	17-16527	$0.50(OTS)
USNRDL-TR–	**(Non-AEC)**	
596	17-15643	$1.60(OTS)
605	17-15644	$1.60(OTS)
606	17-15804	$1.60(OTS)
608	17-15645	$1.10(OTS)
619	17-15646	$1.60(OTS)
VDIT–	**(Swedish)**	
Sa	17-16593	Dep.(mc)
16(Ind.61/62)	17-16747	Dep.(mc)
68	17-16147	Dep.(mc)
70	17-16148	Dep.(mc)
WAPD-PWR–		
TE-103	17-17572	Dep.(mc); $1.10(fs), $0.80(mf) OTS
TE-128(Rev.)	17-17573	Dep.(mc); $1.10(fs), $0.80(mf) OTS
WAPD-T–		
1461	17-17574	Dep.(mc); $2.60(fs), $0.89(mf) OTS
1566	17-16235	Dep.(mc); $2.60(fs), $0.92(mf) OTS
WCAP–	**(Misc.)**	
1635	17-17428	Dep.(mc); $9.60(fs), $3.65(mf) OTS
Y–		
1403	17-15890	Dep.; $0.50(OTS)